



Technologies and Business Value of Cloud Computing: Strategy  
for the Department of Information Processing

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## ABSTRACT

### KEMI-TORNIO UNIVERSITY OF APPLIED SCIENCES

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<p>This research focuses on the area of cloud computing, an important research area in computer and service science. The general aim of this research is to emphasize the business value of cloud computing to businesses. The objective of this research is to explore the economic benefits of cloud computing in order to promote its use in business and the education sector. Consequently, the research recommends the adoption of cloud computing by the Kemi-Tornio University of Applied Sciences.</p> <p>The concept of cloud computing has been studied extensively. However, it appears that a vast number of people only have a vague understanding of the concept, especially from an economic perspective. The need to look at cloud computing from an economic point of view created the necessity for this research. To accomplish the objectives of this research, technologies of cloud computing are studied. The concept of Cloudonomics and its implications are examined and described. Subsequently, the insistent economic benefits of cloud computing are identified and scrutinized.</p> <p>Based on the research questions and objectives, the exploratory research method was chosen. Exploratory research is relevant for this research because the cloud computing field of study was made possible by this research method. This research relies heavily on secondary data sourced from books and academic and business journals on service science and the cloud computing and Cloudonomics concepts. All sources are authored by renowned authors. All literature is critically analyzed and interpreted. Additionally, the interview research technique is employed in the practical implementation of the work.</p> <p>The output of this research is a practical recommendation of a cloud computing adoption strategy for the Kemi-Tornio University of Applied Sciences. The proposed recommendation focuses on the Department of Information Processing. Additionally, in order to encourage IT as a business strategy, a direction for future research in this specific field is suggested.</p>	
Keywords: cloud computing, Cloudonomics, economic value, service technology	

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## GLOSSARY

<b>API</b>	- Application Programming Interface
<b>AWS</b>	- Amazon Web Services
<b>Capex</b>	- Capital Expenditure
<b>CSP</b>	- Cloud Service Provider
<b>CTP</b>	- Cloud Technology Provider
<b>CMP</b>	- Cloud Management Platform
<b>CRM</b>	- Customer Relationship Management
<b>EC2</b>	- Elastic Compute Cloud
<b>ERP</b>	- Enterprise Resource Planning
<b>GaaS</b>	- Gaming as a Service
<b>IaaS</b>	- Infrastructure as a Service
<b>ISP</b>	- Internet Service Provider
<b>Opex</b>	- Operational Expenditure
<b>PaaS</b>	- Platform as a Service
<b>S3</b>	- Simple Storage Service
<b>SaaS</b>	- Software as a Service
<b>SLA</b>	- Service Level Agreement
<b>SOA</b>	- Service Oriented Architecture
<b>TCO</b>	- Total Cost of Ownership
<b>UDDI</b>	- Universal Description, Discovery and Integration

## 1 INTRODUCTION

Over the last decade, information technology (hereinafter IT) substantially advanced and integrated into daily life. However, IT is an evolving paradigm. The shift from mainframe to client/server systems came and passed. Today, there is a shift from client/server systems to hosted services. This latest shift in IT is the trend of managed IT, hosted services and virtualization—a trend known as cloud computing (hereinafter cloud). This shift may be attributed to the advancements in Service-Oriented Architecture (hereinafter SOA) and Web services, as two of several paradigms that undertake to deliver IT as a service. Microsoft (2010) argues that the importance and impact of the shift from client/server systems to cloud is similar to that of mainframe to client/server systems.

Cloud refers to a paradigm of offering mass computing services over the Web. Cloud enables IT systems to be scalable and elastic, allowing for flexibility. In contrast to traditional IT, cloud consumers do not have to determine what and how much computing resources they need upfront. Instead, consumers access computing resources on demand. (Kundra 2011, 6.) Cloud is cost effective and it removes common problems of IT such as purchasing and maintenance. Cloud increases productivity as it allows organizations to focus their human resources on production driving activities instead of IT infrastructure upkeep. These notable points translate into the business value of cloud, thus, the economics of cloud. Understanding the true economics of cloud is unquestionably critical to a well-informed cloud strategy and overall success in the cloud (Williams 2012, ix). Cloudonomics is at the heart of this understanding. The business value of cloud, economic or otherwise, created and captured through understanding Cloudonomics is used in this study to argue for the adoption of cloud in different organizations.

For the purpose of this research, the definition of cloud proposed by the United States National Institute of Science and Technology (hereinafter NIST) is adopted. The term Cloudonomics is also defined in this chapter, based on Weinman (2012).

## 1.1 Cloud and Cloudonomics

Cloud on its own is not a new concept, although this view depends on an individual's knowledge of the subject area. Sosinsky (2011, xxv) states that cloud is something people have been using for a long time; it is the Internet, along with all its systems used to provide Web services to consumers.

Cloud standardizes and pools IT resources and automates them to ensure that there is limited or no need for human intervention. Mell and Grance (2011, 2) introduced the NIST model that defines cloud as a model for allowing universal, on-demand network access to a shared pool of managed IT resources that are made available to a client with little human effort. The NIST model comprises of five essential characteristics of cloud together with three service models and four deployment models, which are discussed thoroughly in Chapter 3 of this thesis. Figure 1 below is a high-level abstraction representation of the cloud model as conceptualized by the writer of this work.



**Figure 1.** Cloud overview




Figure 1 illustrates what cloud is by showing the interaction between cloud and clients. From the point of view of clients, cloud is a massive resource pool to which they can connect and use services as required. However, an ecosystem of systems exists beneath that pool that makes all interactions possible. Pooled resources mean a virtually



unlimited number of clients with Internet access can connect to a cloud database and access information simultaneously. The use of E-mail today, social network sites with billions of subscribers, programming platforms and massive online game platforms may not exist without virtualization technologies and pooling of computing resources.

Weinman introduced the Cloudonomics concept in the cloud business in 2008. Cloudonomics is a subsection of cloud concerned with the financial implications of cloud. Its focus is on establishing and presenting the business value of cloud. Cloud services enable businesses and governments to minimize the complexity and cost of starting and maintaining high-tech data centers. Such data centers require high capital expenditure (hereinafter Capex) and high continuous operational expenditure (hereinafter Opex).

Cloudonomics explores cloud using a combination of technology and economic tools to measure its economic value to service suppliers and consumers. There are significant economic advantages of using cloud, as shown in Figure 2 below. Figure 2, adopted from Microsoft (2010, 2), is a representation of the opportunities of cloud as compared to what this thesis refers to as traditional IT.

		Technology	Economic	Business Model
<b>Mainframe</b>		Centralized compute and storage Thin clients	Optimized for efficiency because of the high cost	High up-front costs for hardware and software
<b>Client/Server</b>		PCs and servers for distributed compute, storage, and so on	Optimized for agility because of the low cost	Perpetual license for OS and application software
<b>Cloud</b>		Large DCs, ability to scale, commodity hardware, devices	Efficiency and agility an order of magnitude better	Ability to pay as you go, and only for what you use

**Figure 2.** Cloud opportunity (Microsoft 2010, 2)

Figure 2 shows that cloud has advantages over old technologies. Distributed computing is still used in the cloud as it was in client/server. However, compute resources in cloud

have the ability to be scaled. Cloud is also economically more efficient and it gives value and flexibility to consumers as they only pay for what they use. While there are concerns about the technical complexities of cloud, businesses understand that the underlying economics have a much stronger influence on business growth and profitability (Microsoft 2010, 2).

## 1.2 Motivation

For a vast number of companies, the journey to the cloud is still troubled with uncertainty and confusion. Companies are spending money on IT services provided externally as part of their long term integrated IT supply chain (Williams 2012, x). With this view in mind, one can assume that businesses do consider cloud. However, they have reservations due to their IT status quo and cloud concerns. It is evident that there is a need for more research in this particular area of IT in order to help those undecided realize the full power of cloud. Even though similar studies that highlight the business value of cloud have been carried out, this research is necessary because these studies do not stress the means through which the value is created and captured by all parties concerned. It is through stressing some real life scenarios of value creation that cloud adoption can be promoted successfully.

The way information is stored and retrieved affects business decision making and in turn influences operations. The need to understand how information is stored and served is of vital importance to any Chief Information Officer and the entire organization. Cloud technologies such as the service and deployment technologies have been studied extensively by various institutions. Using these studies, the financial implications of cloud may be conceptualized. Today, cloud is at the core of computing and information retrieval. Therefore, it has become a need for service providers and consumers alike to understand what economic value cloud offers over traditional data center environments. The need for a better understanding of cloud's economic value created a need to study the subject area and gave rise to the concept of Clouconomics and subsequently, the need for this thesis.

Weinman (2008) advocates as one of his 10 Laws of Clouconomics that public clouds differ from conventional data center setups in three ways: first, they offer true on-demand services enabled by pooled resources. Second, well-established public cloud providers operate at a scale much greater than private clouds of all sizes. Third, clouds naturally have the benefit of being all around the globe, stemming from their design. Clouds effectively use these fundamental differences to sustain strategic competitive advantage over competing conventional data center setups (Weinman 2008).

### 1.3 Objectives

The objectives of this research are to study cloud technologies, cloud service and deployment models in detail and present them as benefits of cloud. This study determines the business value of cloud and promotes cloud adoption in business and education, in the face of existing concerns regarding information managed outside office premises. In order to achieve these objectives, the fundamentals of cloud, the technologies, and service and deployment models are studied in detail. The economics of cloud is also studied and given special attention as a presentation of the financial aspect of cloud.

Additionally, as an attempt to contribute to the understanding of the cloud concept, the research outlines definitions and descriptions of existing cloud terms and concepts. New perspective of the frequently misunderstood concepts of cloud technologies forms the basis for understanding the underlying technologies of cloud and subsequently its business value. This research also aims to build upon the current level of comprehension of cloud by analyzing the characteristics of cloud.

As practical output of this research, recommendations for the Kemi-Tornio University of Applied Sciences (hereinafter KTUAS) to adopt cloud are proposed. The proposal aims to pave the way for the integration of cloud technologies in teaching and administration, particularly in the Department of Information Processing.

#### 1.4 Structure of the thesis

The rest of this thesis is divided into 6 chapters as follows. Chapter 2 discusses the research scope, questions, and methodology. Chapters 3 and 4 describe the concepts of cloud and Cludonomics respectively. Chapter 5 presents the influence of open source software in the cloud. Chapter 6 suggests ways in which KTUAS can integrate cloud technologies into teaching and learning. Finally, Chapter 7 sums up the thesis by presenting the conclusion and discussing the findings of the study. Chapter 7 ends by suggesting directions for further research and presenting possible future developments in the discipline of Cludonomics.

## 2 RESEARCH SCOPE, QUESTIONS AND METHODOLOGY

The focal point of this research topic is cloud computing (hereinafter cloud) and its potential economic value to businesses. In an attempt to achieve one of the objectives of this thesis, the work takes a close look at and examines cloud based business models. Cloud deployment and service delivery models are determined by the business model a provider has laid out. In order to understand how and why a provider interacts with their clients, there is a need to look at their business strategy, from which a business model is constructed. This chapter describes the scope of this study, questions, and the research methodology.

### 2.1 Research scope

This research highlights how, as Williams (2012, xi) states, “we as a networked, interconnected global society, can best leverage the extreme economies of scale associated with the cloud”. The research analyzes methods by which cloud service providers (hereinafter CSP) together with consumers could best utilize the power of this abundant and low-cost technology. This research explores the taxonomy and ontology of cloud. The work analyzes business models of existing CSPs, the products they offer, and their pricing models whilst describing the definition and technologies of cloud. The definition of cloud in this research is based on existing works; therefore, this study does not introduce new terminology. Furthermore, this research recommends the adoption and integration of cloud into the classroom at the Kemi-Tornio University of Applied Sciences (hereinafter KTUAS).

This work does not make the decision for companies to move to cloud nor does it claim that IT without cloud is obsolete. It merely serves to reiterate and add upon the benefits of being associated with the cloud, benefits which have been examined in numerous research works. The cloud business is democratic in nature. Cloud is an Internet based business; therefore, it is an open market per se. However, this thesis does not discuss the politics of cloud, i.e. democratization of IT, which is in itself an important aspect of cloud and deserves dedicated research. Cloud being a business strategy is a topic that is

worth exploration. However, this research does not go into the details of strategic cloud, instead, the subject is considered and recommended for further study.

Amazon Web Services (hereinafter AWS), Google and Microsoft are some of the top providers of cloud and they often appear in cloud business studies with objectives similar to this study. However, this study does not include these companies. The exclusion is on the basis that the companies have been extensively studied and the possibility of adding new input is limited. Nonetheless, it is important to note that business models of these companies and their pricing models in particular, have a substantial influence on the cloud business.

## 2.2 Research questions

In order to achieve the objectives of this research, three main questions have been identified and listed below.

1. How are the cloud service and deployment models adopted in business? What are the underlying technologies driving these models?

A vast number of people use the phrase cloud interchangeably with the phrases pay-per-use or on-demand to refer to attributes found in the cloud. However, from an economic point of view there are significant differences between the phrases. By emphasizing their differences and giving compatible examples, this thesis makes a connection between techniques of deploying cloud infrastructure and the choices of delivering cloud services.

2. How does Clouconomics influence cloud business models and why is it important to understand the economics of cloud?

Different cloud providers have different business models that determine what services they offer. It is common for cloud providers to offer their software for less than a euro and still make millions in returns. Clouconomics describes the

underlying elements of these types of business models. Clouconomics suggests that cloud reduces IT costs, improves productivity, and increases returns. To support and prove this standpoint, it is important to understand how the business models make cloud such a lucrative business. Ways in which the implied benefits are generated have to be identified and contrasted to traditional IT cost savings mechanisms, if there are any.

3. How can KTUAS utilize cloud to improve learning in the Department Of Information Processing and decrease IT costs?

University institutions are driven by quality education and cost reduction. In Finland, costs are covered by the state, creating limited possibilities for institutions to control their finances. However, the state requires universities to reduce costs and be self-sufficient. Quality of education is a top priority for all universities followed by security and privacy. Cloud technologies offer KTUAS the capability of improving learning whilst keeping a significant level of control over data and reducing IT costs.

### 2.3 Research methodology

Combining the concepts of cloud and Clouconomics and making business sense of them is a new undertaking. This work analyzes those concepts; hence, it is mainly qualitative in nature. The work brings together data from various sources and the data is critically reviewed, analyzed, and interpreted. The qualitative research methodology was chosen because the study's theory draws from analyses of various literature and substantial personal input.

This thesis involves mostly exploratory research based on literature. The research is exploratory because it serves a purpose of obtaining an understanding of a concept or of helping clearly define a problem. Several seemingly misunderstood concepts of IT specific to cloud are explored and presented to shed light on cloud infrastructure.

For the practical part of the work, the research utilizes the interview research technique. In order to ensure informed decisions while making the recommendations, semi-structured face-to-face interviews were conducted with four members of staff of the Department of Information Processing. The members included the Head of Department, the Principal Lecturer, and two Senior Lecturers. Additionally, an IT Specialist in the Department of Information and Communication Technology (Lappia) was interviewed. Lappia is the information technology provider for KTUAS and the Lappia Vocational School in Tornio. These individuals were chosen because they possess the necessary technical knowledge and are in best positions to understand the needs of students and teachers. Moreover, these interviewees are in best positions to influence the implementations of the recommendations.

Results from literature review and analysis form the theoretical part of this work, while results from the interview interpretation form the practical part. The theory involves a thorough examination of the concepts and technologies of cloud. Findings from this examination are used to formulate practical recommendations.



### 3 TAXONOMY AND ONTOLOGY OF CLOUD

This chapter presents the concept of cloud computing (hereinafter cloud), the technologies of cloud and the classification of cloud services using models. The first section of this chapter describes the concept of cloud and presents an overview of cloud's architecture. The second section carries on to present the technologies of cloud by highlighting the tools used to build cloud infrastructures and manage inter-cloud communications. The third and fourth sections discuss the taxonomy of cloud, mainly using the model proposed by the National Institute of Science and Technology (hereinafter NIST).

#### 3.1 Cloud concept

Attempts to reach consensus on one scientific definition of cloud have proven futile. This lack of consensus has prompted cloud service marketers to come up with definitions that suit their needs. Nevertheless, some cloud related expressions such as, virtualization, resource pooling, distributed networks, client and back-end, multi-tenancy and pay-as-you-go have become generally accepted as forming the framework for defining cloud.

Cloud is a model that allows universal, on-demand access to a network of a shared pool of managed, pay-per-use IT resources such as servers, development platforms, applications, and services. These resources need to be easily and quickly provisioned and delivered with minimal management effort by the service provider. (Mell & Grance 2011, 2.) Cloud is a technology whereby physical resources or servers are pooled and virtualized to form a multi-tenant network capable of massive computation power. The resources may be in one or many different physical locations. Cloud resources are managed and distributed based on service classifications. The classification assumes three standard service models: Software as a Service (hereinafter SaaS), Platform as a Service (hereinafter PaaS), and Infrastructure as a Service (hereinafter IaaS) and four deployment models, public cloud, private cloud, community cloud, and hybrid cloud.

All cloud deployments exhibit certain characteristics that qualify them as cloud establishments.

Mell and Grance (2011, 2) identify five essential characters of cloud. For an establishment to call itself a cloud it should exhibit the following characteristics:

- 1) On demand self-service for users: a user can get access to a computing resource, be it server time or virtual machine, as needed automatically without any human intervention from the side of the service provider.
- 2) Broad network access: resources are made available and accessible by standard means that encourage use of varied thin and thick clients, i.e. mobile phones, laptops, tablets and desktop computers.
- 3) Pooled resources: resources are pooled to create a massive multi-tenant system that dynamically provision and de-provision resources. The pooling system should abstract information regarding the physical or geographical location of the resources from the user.
- 4) Instant elasticity: resource elasticity is critical to reducing costs and time it takes services to reach consumers. Elasticity gives the consumer the sense of unlimited resource capabilities and availability. For reducing costs, elastic resource provisioning should be scaled outwards and inwards depending on demand.
- 5) Measured resources: this is the requirement that cloud systems automatically control resource usage by using some metering systems. The metering systems should give the user adequate information about their usage while keeping a level of abstraction. The metering or monitoring system should be transparent and agreed upon by both the user and service provider.

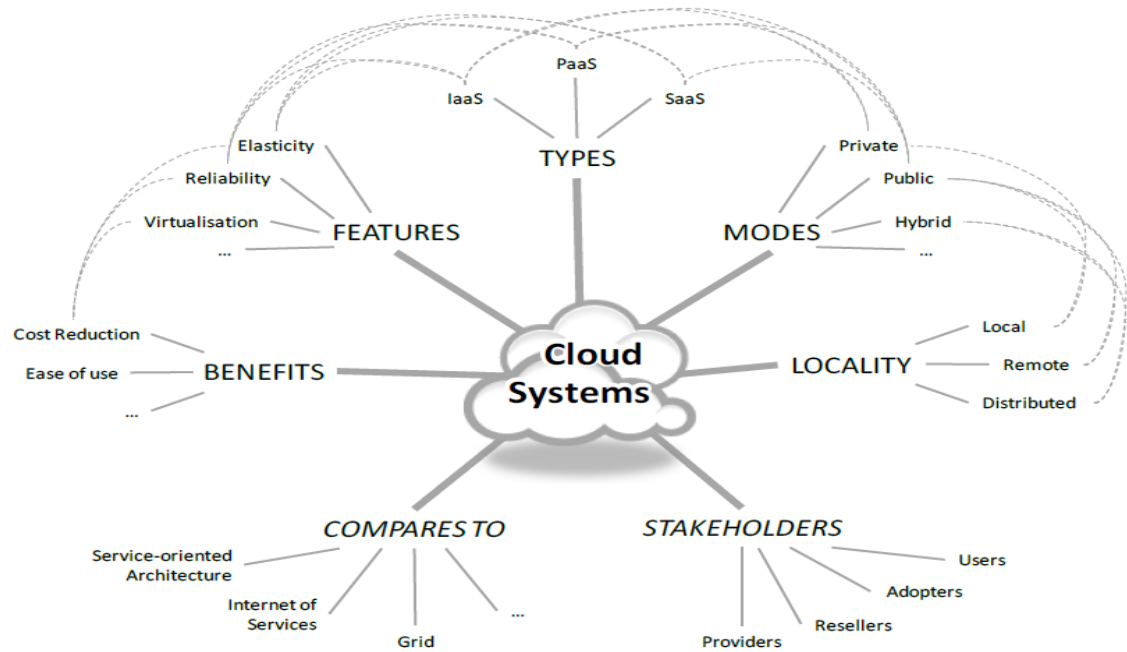
### 3.2 Cloud ontology

Cloud inherits many protocols, standards, and technologies from the Internet. Cloud took Internet communication tools and built on them to make self-controlling automated systems. Resemblance aside, one attribute of cloud distinguishes it from the Internet;

cloud gives developers the capability to develop software from component parts, also known as composability (Sosinsky 2012, 45). These parts may be located on one physical system or on several systems located in different geographical locations. Many of the protocols when coupled form protocol sets used to administer transactions in the cloud. Some of the protocols already in use by the Internet are prevalent in the cloud. These protocols are such as, Hyper Text Transfer Protocols (hereinafter HTTP), used to transfer messages over the World Wide Web (hereinafter Web), Secure Hyper Text Transfer Protocol (hereinafter HTTPS), an extension of HTTP, to send data securely over the Web, and the Extensible Markup Language (hereinafter XML), used to format messages.

By the notion of pooling resources, cloud functions by making components on distributed networks work together for the purpose of service delivery. However, for this to take place and to ensure compatibility, standard protocols for communication are required. Inter-process communication in the cloud relies on a set of protocols (Sosinsky 2012, 45). Message transfer standards such as HTTP and XML are used by combinations of protocols such as the Simple Object Access Protocol (hereinafter SOAP) and some Web Services Description Language (hereinafter WSDL) based discovery tools for locating and describing resources. SOAP is an XML-based protocol for allowing applications to exchange messages. WSDL is an integral part of the Universal Description, Discovery and Integration (hereinafter UDDI), a registry for Web services. Due to virtualization and data center design, cloud components are modular and distributed; therefore, their locations need to be mapped.

Cloud infrastructure naturally allows for economies of scale as it is designed for multi-processing and load balancing. The automation in the infrastructure that reduces human intervention allows machines to work at a rate far beyond that of humans. The automation gives cloud the ability to cater to millions of global consumers simultaneously. The existence of cloud alone necessitates an existence of a vast number of players in the business of service computation. Figure 3 below, adopted from Schubert (8), is an opinion on the many aspects that make up cloud. The title of the figure has been altered to suit the context of this thesis.



**Figure 3.** Opinion on the main aspects of cloud (Schubert, 8)

Figure 3 represents a cloud system with some of its main forming factors. Clouds have types, as seen later in this chapter. Clouds are typically classified into three modes and these modes in some cases determine the locality of a cloud. There are several stakeholders in the cloud business. These stakeholders create the logic for the existence of a cloud system. Cloud is huge and requires its due diligence from all stakeholders. Being a distributed service oriented system cloud inherits some of its architecture design from other Web service paradigms. One notable example of this inheritance is the use of the Service Oriented Architecture (hereinafter SOA) paradigm.

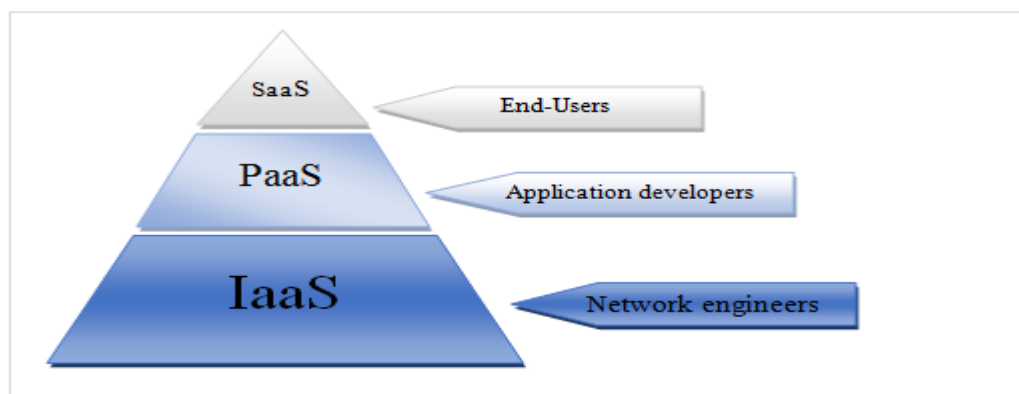
SOA is the standard method for requesting services from distributed components and managing the resulting processes. SOA is not a feature of cloud; in fact, the two technologies co-exist. Since the service requests are done on a distributed network, SOA becomes a specification for providing platform and language-independent services. SOA is responsible for providing the translation and management layer for service requests and transactions. This is necessary because clients requesting services, components providing the services, protocols used to transport messages, and the responses vary widely. (Sosinsky 2012, 271.) SOA allows for clients and components written in different languages to communicate. It also ensures that there are no barriers

in communication no matter what messaging protocol and networking protocol are used. In addition, SOA provides standards used to transport messages and makes the necessary infrastructure possible. SOA further provides access to reusable Web services over a TCP/IP network. (Sosinsky 2012, 271.)

### 3.3 Cloud service models

#### 3.3.1 Overview of SaaS, PaaS, and IaaS




Service delivery and differentiation in the cloud business comprises of several models, with three being the main models, SaaS, PaaS, and IaaS. Service models are useful to classify cloud capabilities and help identify services offered by specific vendors. There are thousands of cloud service providers (hereinafter CSPs) on the market offering different kinds of services. Some providers offer hosted applications, normally accessible through a Web browser. Such providers are known as vendors of SaaS. Other providers offer environments for developing applications. These providers are vendors of PaaS. Providers of computing services are known as IaaS providers. These three models can be represented in a stack. Figure 4 below shows these three service models with their target markets. The concept of the figure is adopted from Kepes (2011, 3). However, the figure is modified to present the opinion of the writer of this work. The original figure is intended to show the three service models of cloud, while the figure below is intended to highlight the target market of each service model.



**Figure 4.** Cloud stack (Kepes 2011, 3), modified figure

In Figure 4, the three main service models form the cloud stack. SaaS is a user-facing service. SaaS applications are ready for use and Web based; therefore, they are targeted at end-users. PaaS is primarily for application developers and it consists of tools necessary for deployment and development. IaaS is the backbone of the stack. IaaS consists of hardware and software that keep the upper layers functioning. IaaS services are targeted at consumers with various computing needs, i.e. storage and networking.

SaaS, PaaS, and IaaS are the three best known and most utilized service models on the market. There are several less known models that tend to be embedded in the primary models i.e. Compute as a Service, Desktop as a Service, Storage as a Service, Identity as a Service, Email as a Service and more. This thesis concentrates only on the three commonly known service models. It has been established that cloud service model components build on one another, with IaaS serving as the foundation layer. Services in a higher layer may include services from the preceding layer. This service relation is further illustrated in figure 5 below, adopted from Savolainen (2012, 4), including the service models' access mechanisms and the services they offer.

Service Class	Main Access & Management Tool	Service content
 SaaS	Web Browser	<b>Cloud Applications</b> Social networks, Office suites, CRM, Video processing
 PaaS	Cloud Development Environment	<b>Cloud Platform</b> Programming languages, Frameworks, Mashups editors, Structured data
 IaaS	Virtual Infrastructure Manager	<b>Cloud Infrastructure</b> Compute Servers, Data Storage, Firewall, Load Balancer

**Figure 5.** Cloud computing service models (Savolainen 2012, 4)

Figure 5 shows the three service models, raises their main access and management methods, and presents some of the contents of each of the services. The figure above, to

be considered from the bottom up, is an attempt to show the interdependency of the three models or layers. Infrastructural services built on compute services, security, and load balancing services are at the bottom; therefore, forming the foundation of cloud services. The platform layer, which is the most componentized layer, offers platforms where programmers can develop applications that they can host on the infrastructure or software layers. PaaS layer may use IaaS to help it locate and provision development tools or components on a distributed network. Finally, the software layer, also known as the application layer, is responsible for provisioning ready-to-use applications such as Enterprise Software for businesses or social networking interfaces for personal and business use, normally via a Web browser. Applications offered on the SaaS layer, if developed in the cloud, are developed on the PaaS layer.

### 3.3.2 Exploring SaaS

Software as a Service is the capability that a service provider offers to a customer to use the provider's software hosted on the provider's cloud infrastructure (Badger & Bohn & Chu & Hogan & Liu & Kaufmann & Mao & Messina & Mills & Sokol & Tong & Whiteside & Leaf 2011, 17). SaaS, often referred to as on-demand software service, is a service model through which CSPs distribute software to consumers, by making the software available online, instead of selling licenses. The CSP controls the underlying infrastructure and in some cases, the functionality of the software (Badger et al. 2011, 17).

Savolainen (2012, 5) suggests that SaaS is the most known and most widely adopted of the three service models. In the SaaS model, a CSP often licenses an application or software to customers as an on-demand service (Savolainen 2012, 5). Applications in SaaS can be provided through a subscription service or on a pay-as-you-go basis. However, software is increasingly being offered at no cost. These free services are financed by revenue from premium services or returns from advertisement. Offering free products is a strategic part of a cloud business model, discussed later in this thesis. Kepes (2011, 9) compiled a list of the characteristics of SaaS.

- 1) Software is accessible through the Web.
- 2) Services are normally paid for on a pay-per-use basis.
- 3) The customer is not responsible for any software patches and upgrades.
- 4) The customer is limited to user-specific configuration settings.
- 5) Software is client independent; therefore, there are no operating system requirements.
- 6) One-to-many system of delivery: one piece of software is made available to multiple users simultaneously.
- 7) Application Programming Interfaces (hereinafter API) are freely accessible to allow for easy integration between different software.

SaaS businesses grow rapidly because they finance their own growth. A system where customers pay upfront for use of software means the provider has capital to improve the product. The distinction between the three service models is becoming increasingly blurred due to some providers offering services in two or more service models. Table 1 below is a comparison of products and pricing models of some of the most notable SaaS providers.

**Table 1.** SaaS providers, products offered and types and pricing model

COMPANY	PRODUCT(S)	PRODUCT TYPE	PRICING MODEL
Google	Google Apps (Docs, Gmail, Talk)	Office Suit, Social	Pay-as-You-Go
SalesForce	SalesForce.com	CRM	Pay-as-You-Go (Monthly)
Facebook	Facebook	Social networking	Free, Pay-as-You-Go
Apple	iCloud (iTunes, iWork, iLife)	Media suit, Office suit	Free, Pay-as-You-Go
Microsoft	Microsoft Office 365	Office Suit	Subscription

Table 1 is a list of only some of the major players in SaaS. Most of the providers of SaaS started with SaaS as the sole business. However, many of them evolved and began offering services in all the three service models. The pricing models of providers using



the same service model tend to be alike. The only variation may be in their frequency of billing. Some providers bill their customers monthly and some quarterly or yearly. This variation is also noticeable in the following sections.

### 3.3.3 Exploring PaaS

PaaS offers the capability of deploying user-created applications onto cloud infrastructure owned by a CSP. Applications are created using programming languages and APIs supported by the service provider. As in SaaS, users do not have control over the infrastructure on which they deploy applications. The user only has control over the application they deploy and in some cases, some customization of the hosting platform. The management of servers, networks, operating systems or storage is all service provider reserved. PaaS is a development platform; therefore, it can be defined as a computing platform for developing and deploying Web applications easily. (Mell & Grance 2011, 2-3; Badger et al. 2011, 17.)

Acting as the go-between for SaaS and IaaS, middleware in the form of PaaS has gained momentum in popularity because it effectively mixes the simplicity of SaaS with the power of IaaS. PaaS eliminates the complexity of buying and maintaining the infrastructure on which applications are built and hosted. Traditionally, developers created their own programming environments, a task that included purchasing hardware and software required to develop applications. In addition, developers performed maintenance and compatibility assurance tasks. PaaS has shifted the work of procurement and maintenance to CSPs. As a result, developers have been afforded the time to focus on creating quality software.

PaaS is a broad category of application infrastructure or middleware services including business process management and databases. However, PaaS is commonly associated with only one service, i.e. application platform. Application infrastructure is a platform for application development; therefore, it includes middleware technologies required for runtime management of applications developed in the cloud (Natis & Pezzini & Cantara

& Skybakmoen Thoo & Schulte & Feiman & Feinberg & Knipp & J. Murphy & T. Murphy & Malinverno & Duggan 2011). These technologies include:

- 1) Application platforms in the form of servers
- 2) Application integration software such as Enterprise Service Bus
- 3) Data integration tools
- 4) User feedback & community platform technologies
- 5) Application development and life cycle management tools
- 6) SOA tools
- 7) Platform security technologies
- 8) Composite application platform (Natis et al. 2011)

Large SaaS providers who provide Enterprise Software often end up providing PaaS. This is because PaaS adds value to their product by allowing customers to build applications pluggable to the provider's main product. It is easy for these providers to offer PaaS because they already have the infrastructure in existing data centers. Force.com, founded on the existing SaaS data centers of Salesforce.com, is a good example of this diversification strategy. Table 2 below, is a list of only some of the largest providers of PaaS.

**Table 2.** PaaS providers and their products

COMPANY	PRODUCTS	PRICING MODEL
Microsoft	Microsoft Azure	Pay-as-you-go (6 months, yearly)
SalesForce	Force.com	Pay-as-you-go (yearly)
Google	Google App Engine	Pay-as-you-go (monthly)
Appistry	Cloud IQ	Pay-as-you-go (monthly)
GCloud 3	gPlatform	Pay-as-you-go (monthly, yearly)

Table 2 shows that all PaaS only offer one form of subscription, pay-as-you-go. Most providers bill customers on a monthly basis except for the two biggest PaaS providers,

Microsoft and Salesforce. The former does billing half-yearly and yearly, and the latter, yearly. Most of these providers have diversified and now offer IaaS services too. PaaS remains to be a steady growing service model as cloud benefits attract an increasing number of Independent Software Vendors (hereinafter, ISV).

### 3.3.4 Exploring IaaS

Mell and Grance (2011, 3) define IaaS as the capability provided to the consumer to access on-demand fundamental computing resources such as networks, virtual processors and storage and other virtual resources that allow users to deploy and run various software. Even though users do not manage the underlying infrastructure, they have more control as compared to PaaS or SaaS. In IaaS, users control the operating system, space where applications are stored as well as the applications. Additionally, they have some level of control of networking components, as determined by the Service Level Agreement (hereinafter SLA).

IaaS allows users to create virtual computing systems or networks. For a business, being a subscriber to IaaS is parallel to having servers on its premises, only with benefits of not purchasing, configuring and maintaining the servers. IaaS reduces an organization's IT staff requirements. In the same vein, IaaS improves productivity by allowing employees to focus on productive tasks instead of system management.

In IaaS, hardware utility services are created by the vendor to allow users to easily provision virtual resources on-demand. All the developer has to do is create virtual hardware and they are ready to configure and deploy applications. The whole process of provisioning IaaS is rather clear-cut. A system administrator creates virtual resources such as virtual private servers and virtual private storage by interacting with the IaaS model. Once the virtual systems are created, they are crowded with the desired applications and services, and the environment is complete.

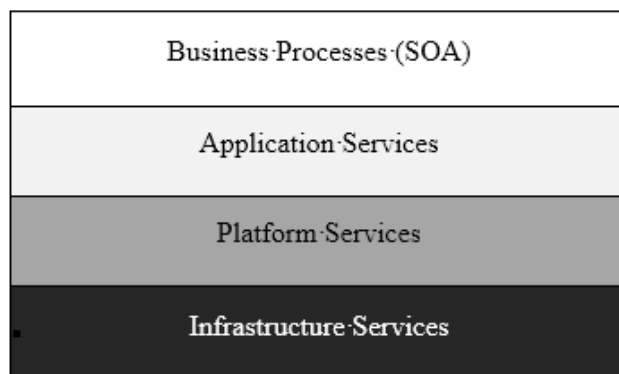
The biggest provider in the IaaS business is Amazon Web Services (hereinafter AWS) with its Elastic Compute Cloud (hereinafter EC2) and Simple Storage Service (hereinafter S3). The table below is a list of some of the major players in IaaS.

**Table 3.** IaaS providers and their products

COMPANY	PRODUCT/ SERVICE	PRICING MODEL
Amazon	EC2, S3	Pay-as-you-go
Rackspace	Cloud Servers	Pay-as-you-go
GoGrid	Cloud Servers, Load Balancers, Cloud Storage	Pay-as-you-go, monthly, semester, yearly
Terremark	Enterprise Cloud	Pay-as-you-go
SoftLayer	Cloud Layer	Pay-as-you-go, monthly

Table 2 shows some of the companies in IaaS, with AWS being the leader in this category. It is common for other CSPs in IaaS to align their product with AWS by making it compatible with the API. IaaS also utilizes the pay-as-you-go system. Unit charging whereby customers are charged per gigabyte is commonly used in this model.

For a better understanding of the operations of cloud and its service models, it is best to partition cloud into four layers that form a cloud ecosystem. Figure 5 below, adopted from Sosinsky (2011, 66), presents the cloud ecosystem.

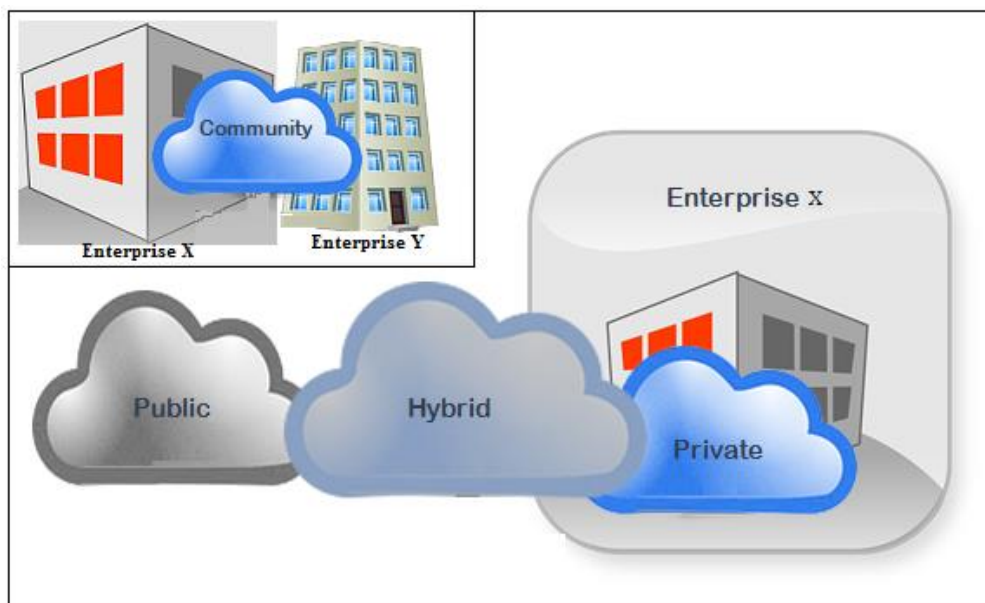


**Figure 6.** The cloud computing ecosystem (Sosinsky 2011, 66)

In Figure 5, the application layer forms the basis for the SaaS model. The platform layer forms the basis for the PaaS model, which was described in the last section. The infrastructure layer is the foundation of IaaS. Therefore, IaaS forms the foundation of the whole ecosystem. According to Sosinsky (2011, 66), IaaS creates a utility computing model. Utility computing implies a resource that can be accessed and drawn from as needed.

### 3.4 Cloud deployment models

Cloud deployment models determine who can access cloud resources and the manner in which resources can be accessed (Lewis 2010, 4). A deployment model defines the physical location of servers and the entity responsible for them. Server deployment may be performed based on four different but closely related models: private, public, hybrid, and community deployment models. The choice normally depends on the organization's evaluation of its needs. Cloud is not to be taken as a silver bullet technology as it requires its due diligence. Each deployment model presents its own benefits and challenges. In Figure 7 below, three clouds are touching to represent their relations. The figure is the thesis writer's conceptualization of the four models and their relations.



**Figure 7.** Cloud deployment models

In Figure 7, a private cloud is owned and managed by one organization. Therefore, a private cloud is found on the premises of the enterprise. However, a private cloud is not always physical as it may be a virtual cloud and may be off-premises; in such a case, a private cloud is on the premises of a CSP. Private and public clouds may be combined to form a hybrid cloud. The hybrid cloud in Figure 7 touches both private and public clouds to highlight that combination. A public cloud caters to the public. The resources are owned and managed by a CSP. A community cloud caters to two or more enterprises with mutual interests. The community cloud in Figure 7 is bordered to indicate that its relation to the other three deployments is limited.

#### 3.4.1 Private cloud deployment model

The infrastructure in a private cloud is provisioned for exclusive utilization by a single organization made of multiple business units. The infrastructure may be located on or off the organization's premises and may be owned, maintained and run by the organization itself, a hired third party or a combination of the two. Large enterprises with well-established IT infrastructures and high privacy needs usually use private cloud set ups (Mell & Grance 2011, 3.)

Infrastructure in an on-premises private cloud is managed by the business that owns it. However, a business that requires a private a cloud does not necessarily need to have its own infrastructure as it can be sourced from a public service provider. In such case, the business purchases a virtual private network that it controls and uses as its own. Private clouds have the following characteristics. Private clouds are well managed, they allow users to provision hardware and software resources in a self-service manner, they can optimize use of resources such as servers and networks, and billing is performed as per use per business unit. The downside of private clouds is that they are cost inefficient. It may be argued that the aforementioned characteristics are similar to those of public clouds. However, there is a distinguishing factor between the two cloud types, control. A private cloud offers more control over the management of services and that ensures privacy and security (Hurwitz & Bloor & Kaufman & Halper 2012, 89). In cases where the benefit of control is outweighed by cost, Hurwitz et al. (2012, 89) suggest some scenarios in which a private deployment should still be considered.

- 1) If an organization manages data that has to conform to certain regulatory standards, i.e. the Finnish Data Act (523/1999) in Finland or the Health Insurance Portability and Accountability Act of 1996 in The United States. These acts require data to be managed internally to ensure privacy and perhaps for audit reasons. In industries such as medical care, finance, and the military data processing is governed by strict regulations. Such regulations may only be implemented in a private cloud.
- 2) If an organization that has already spent huge amounts of Capex on long-term IT objectives, a private cloud may be more suitable than a public cloud. For an organization with a large, well-run data center, moving to a public cloud may cost more than running a cloud privately.
- 3) If a business's primary function is performance and require 99, 99 uptime, a private cloud may be a most viable option.
- 4) If an organization has a large clientele to which it offers IT hosting services, a private cloud may present revenue opportunities.

### 3.4.2 Community cloud deployment model

As in a private deployment, infrastructure is provisioned for utilization by a specific user; however, the user is a community formed by organizations with common interests. Common interests include security requirements, compliance laws, and policies. The infrastructure, which may be on or off premises, may be owned, maintained by one or more of the members of that community or a third party. (Mell & Grance 2011, 3.)

This model presents advantages of being cost effective and ecological as infrastructure is shared among two or more organizations, reducing individual costs and number of data centers. Government departments and agencies requiring access to the same data may use this model. In Finland, local registrar offices around the country collect personal data of citizens and non-citizens that if needed the education and police department could access.

### 3.4.3 Public cloud deployment model

The infrastructure is made available for open use, not necessarily free use, by the public. Infrastructure is managed and owned by a CSP, an academic institution, or the state. In a public deployment, infrastructure only exists on the premises of the provider. (Mell & Grance 2011, 3.)

Although the differences between the characteristics of private and public models are blurry, the public cloud deployment model represents cloud hosting. The infrastructure is fault tolerant, infinitely scalable, always available, and highly virtualized. This model may be the best option if a business; has a fluctuating demand for its services, offers applications to a large number of users who are not privacy sensitive, does many collaboration projects, and develops applications that it wishes to rapidly create and deploy.

Public CSPs offer their services in three categories. The first category is user self-provisioning; the user purchases services and pays on a per-transaction basis. The second category is advanced provisioning whereby users sign a contract with the provider in advance for a predetermined bundle of resources, which they receive as services. The user is billed monthly or they pay a flat fee. The last category is dynamic provision; resources are allocated when the user needs. When they are done with them, they are de-provisioned. The user is billed on a pay-per-use basis.

### 3.4.4 Hybrid cloud deployment model

This model is a combination of two or more models. Infrastructure of two or more distinct organizations is bound together by standardized or proprietary technology, i.e. cloud bursting, designed to enable data or application portability (Mell & Grance 2011, 3). The infrastructure is required both on and off premises. This model allows businesses or organizations to take advantage of the security and privacy available in a private set up while still enjoying cost benefits of the public model. Data that needs top



security is hosted in a private cloud and data that needs standard security can be moved to a public cloud.

One of the most important technologies that enable hybrid clouds is cloud bursting, the technology of deploying private applications into public clouds. Cloud bursting enables an application to run in a private cloud and “burst” to a public cloud when needed. Its deployment functionality makes cloud bursting a deployment model in itself. Being a combination of two or more infrastructures, a hybrid deployment inherits security attributes from private infrastructure and fault tolerance and scalability attributes from the public side. However, hybrids are not flexible as private clouds due to being a mixture of different models. The hybrid deployment is becoming increasingly popular in organization because of its combination of two models.

## 4 CLOUDONOMICS

This chapter presents the economics of cloud computing (hereinafter cloud). The chapter describes the concept of Cloudonomics while highlighting some of its most important aspects. Aspects such as the economies of scale, cost savings, and reasons why cloud is attractive are highlighted. The first section of the chapter describes the concept of Cloudonomics and briefly considers IT as a business strategy. The second section presents the four mechanisms that this thesis wishes to highlight as the driving forces in cost savings experienced in the cloud. Special attention is drawn to these mechanisms as they help understand how cost savings are generated in the cloud. The third section focusses on cloud based business models, while the last section discusses the influence of cloud on the gaming industry.

The economic aspects of cloud are some of the justifications for businesses to consider sourcing IT resources from cloud. Cloudonomics in its simplest form is cloud and economics. One of the benefits of cloud adoption by a business is cost savings. Despite the fact that cost savings is generally accepted as a realistic benefit, how these savings are generated still remains a mystery to many businesses. This mystery continues to hamper justification of cloud adoption.

### 4.1 Cloudonomics concept

The Cloudonomics concept entails an examination of the business value of cloud, i.e. the financial implications of cloud on business. For an existing business, Cloudonomics means, among others, low-cost outsourced expert IT services that may mean moving IT cost from Capex into Opex books. For a startup, Cloudonomics entails, among others, starting operations without the need to evaluate the required IT infrastructure. Cloud gives startups the ability to deploy, launch, and test software without spending a fortune on starting capital. However, cloud may not be beneficial by itself. It needs to be aligned with the strategies of the organization. The alignment ensures that cloud does not disrupt the already existing ecosystem of customers, partners, and personnel with their long-standing company rituals.

There have been discussions about IT being a business strategy. Some analysts argue that IT, particularly cloud, is a business strategy. However, other analysts tend to disagree, referring to IT as an office chore. Nonetheless, it is beneficial when a business is offered the opportunity to focus its human resources on productivity instead of administration. Consequently, it holds true that cloud helps firms create new innovative products and services that result in productivity gains. Some companies would consider such productivity gains strategic. Nevertheless, in a competitive environment productivity gains do not translate into revenue growth. Revenue growth may only be realized if a firm retains all revenue from productivity, in turn creating supplier surplus. On the other hand, competitors experiencing similar gains may forward their gains to consumers in the form of reduced prices in order to attract more customers and undermine competition.

“As information technology’s power and ubiquity have grown, its strategic importance has diminished” (Carr 2003 as cited by Weinman 2012, 21). Carr’s remarks paraphrased mean that IT is a pervasive commodity; hence, it is not a strategy. Moreover, IT does not even matter. It is important to note that Carr made his remarks before cloud existed. Therefore, the remarks do not explain how large cloud service providers (hereinafter CSPs) such as Amazon Web Services (hereinafter AWS) have achieved runaway successes by using cloud as a strategy. According to Weinman (2012, 17), in order to be able to examine whether cloud is strategic, it is crucial to first determine what a strategy is and what being strategic actually means. There are scores of other factors that need consideration with regard to business strategies. However, pursuing the topic of whether or not cloud is a business strategy is out of the scope of this research. There are some benefits identified to adopters that have persuaded firms to adopt cloud.

Clouconomics is responsible for the realization of the following benefits, as outlined by Amazon Web Services (2013):

- 1) No upfront investment: A firm deploying on-premises infrastructure procures expensive hardware and software, installs, and configures it well before business

begins operations. With cloud, upfront infrastructure investment is replaced with low monthly costs.

- 2) Increased productivity: cloud allows firms to move resources from IT infrastructure management to activities that promote innovation and sustainable growth.
- 3) Low ongoing costs: the economies of scale in the cloud allow CSPs to continuously lower prices in turn charge less and less. Moreover, cloud reduces IT labor costs.
- 4) Short time to market: accelerated provisioning, deployment, test, and release ensure that products reach the market as quickly as possible. Compared to traditional IT where a firm has to purchase and configure development environments and then find marketing channels.
- 5) Flexible capacity: firms do not have to waste time determining how much capacity they would need during peak times and how they can do with excess capacity during low demand times.
- 6) Global market: many businesses have had to target their products to specific geographic regions due to costs. Cloud allows businesses of any size to reach customers throughout the world. Cloud has allowed businesses to connect with potential customers they did not know existed.

#### 4.2 Applying the 80/20 rule to cloud

The 80/20 rule, also known as the Pareto Principle, after the Italian economist Vilfredo Pareto who showed that 80% of that country's wealth belonged to 20% of the population. In other words, the 80/20 rule states that for many events, 80% of effects flow from 20% of causes. In IT, this means that 80% of total IT expenditure goes into infrastructure maintenance and only 20% goes into product innovation (Kepes 2011, 2). According to Pettey (2006), at least a third of IT spending by businesses is spent on sustaining the business, not on transforming the business. The investments allocated to changing the business are as low as 20%.

The 80/20 rule may be applied to the cost of time in IT the same way it is applied to monetary costs (Kepes 2011, 2). The time spent on basic tasks such as updating systems and taking backups could be used to develop new applications that actually help a business to grow. Cloudbonomics can ensure that more time is spent on productivity tasks and less on non-core tasks. Figure 8 below, adopted from Kepes (2011, 3), illustrates how time optimization helps a business reprioritize its resources.



**Figure 8.** Ideal distribution of time and resources (Kepes 2011, 3)

As Figure 8 shows, cloud, if aligned with the right strategy, can ensure that the IT department spends 80 % of its time on tasks such as innovating new applications that are at the core of business processes and only 20% on maintenance. Cloud allows businesses to reprioritize IT resources and be more productive. Attaining this ability to dedicate money and time to core businesses is one of the factors that make Cloudbonomics an important aspect of business. The same ability makes cloud a strategy for business growth. Reprioritizing IT resources is not the only mechanism through which cost savings are attained. According to Kepes (2011, 1), savings may also be attained through reduced opportunity cost of running on-premises IT, shifting IT expenditure from Capex to Opex and by minimizing the Total Cost of Ownership (hereinafter TCO) of IT infrastructure.

Opportunity cost in cloud is an effective measure of cost savings. Mankiw (2008, 6), defines opportunity cost as whatever item must be given up to obtain some other item. In other words, it is the loss of other alternatives when one alternative is chosen. In IT, there is a trade-off between maintaining traditional IT infrastructures and moving to the cloud. Applying the opportunity cost to this trade-off, a business has to forego the

economies of scale to maintain the status quo of an on-premises data center, and conversely it may benefit from the economies of scale on the expense of disrupting the status quo. However, as the 80/20 rule indicated, IT maintenance is up to 80% of total expenditure (Kepes 2011, 2). The opportunity cost of not choosing cloud is the benefit that can occur to a business through reprioritization of resources (Kepes 2011, 4).

TCO and types of expenses, e.g. Capex and Opex, can be evaluated as one mechanism for determining value attainment. TCO is a calculation for assessing costs and benefits of owning IT infrastructure. In the cloud, IT is an operational expense instead of a capital expense as it is in traditional IT. The TCO of traditional IT is outweighed by the benefits of hosted services. Paying for IT services as Opex is more cost effective as compared to paying for the same services as Capex. One of the financial benefits, i.e. the flexibility of terminating costs at will, is an appealing feature of Opex that organizations frequently seek. A capital purchased server accrues ongoing costs regardless of whether it is in use or not, contrary to Opex where payments may cease during times when the server is not in use. Another benefit is that Opex allows for decentralization that in turn allows business units to spend money and time on tailored projects. In addition, Opex overcomes expenditure limitations as it gives organizations access to IT that they would not have been able to afford had they had to buy it. Kepes (2011, 5 – 7.) The figure below presents the financial implications of TCO, managed services and cloud, representing Opex. The figure is adopted from Kepes (2011, 5) and the title has been altered to suit the context of this work.

	Internal IT	Managed Services	The Cloud
Capital Investment	\$40,000	\$0	\$0
Setup Costs	\$1,000	\$5,000	\$1,000
Monthly Services	\$0	\$4,000	\$2,400
Monthly Labor	\$3,200	\$0	\$1,000
Cost over three years	\$149,000	\$129,000	\$106,000
Savings Gained	0%	13%	29%

**Figure 9.** Estimated costs of IT resources across three different deployment platforms (Kepes 2011, 5)

Figure 9 is an estimation of costs of infrastructure for two application servers, two database servers and a load balancer. The figure shows that on-premises IT is capital intensive. It requires an investment of US\$40, 000 as startup capital while cloud and managed services do not require any investment at all. While the on-premises deployment may not have any monthly service fees, which is central in the other deployments, its total cost over a 3 year, period is much higher (Kepes 2011, 5). Choosing cloud gives an organization 29% savings.

#### 4.3 Cloud based business models

A business model describes the activities of a business and how a business profits performing those activities (Weill & Malone & D'Urso & Herman & Woerner 2005, 2). This definition can be narrowed down by paraphrasing (Alexander Osterwalder as cited by Ojala and Tyrväinen 2011, 2); a business model is an account of the value offered to a business's different market segments and the value of that business's architecture and people responsible for the realization of this value.

This thesis categorizes cloud business models into two broad categories: Business models of cloud technology providers (hereinafter CTP) and business models of CSPs. On the one hand, CTPs such as Rackspace and VMW provide data center hardware, software, and firmware. Thus, these CTPs have business models that are targeted at other players in the cloud business, i.e. CSPs. CSPs on the other hand, have business models targeted at businesses, governments or individuals who consume cloud services. CSPs business models are further categorized into three subcategories: models for SaaS, PaaS, and IaaS. The three models are discussed below with consideration given to service type, pricing models, delivery models, subscription, and revenue realization. For any industry to be attractive, it has to offer a service that consumers need. Harris (2013) relates cloud's attractiveness to fast food restaurants suggesting that cloud offers their consumers convenience, speed, standardization, flexibility, and the advantages that comes with not having to prepare a meal from the beginning or deploy applications on physical gear from the beginning.

#### 4.3.1 SaaS business models

SaaS business models are synchronous to cloud technology advancement. Advances in cloud imply dynamic growth in SaaS business models. The product in SaaS is software, offered as a service. CSPs charge users according to the type and amount of resources they use. The pricing model in SaaS utilizes 3 pricing strategies as follows: pay-per-user, each user incurs cost individually and the client is billed periodically, usually monthly; pay-as-you-go, charged per number of users and the amount of resources used during a specified time, and Unlimited Use, a client is charged a specified monthly fee, number of users does not count. Transparency is key in service transactions therefore, the CSP has a task to provide a customer with subscription management interfaces able to assist customers to understand how, when and what they are billed for.

Service delivery is a one-to-many system, where the CSP provides an application to multiple users simultaneously. The upside of this delivery method is that it may eliminate many players in the supply chain. The downside is that for a business to be profitable it needs a large number of customers because the method is meant for delivery of software designed to reach large numbers of consumers. Nonetheless, the SaaS industry is the fastest growing and still generates the most revenue. In SaaS, revenue recognition describes the point in time when a vendor can credit revenue for the delivery of its services to a client. When using the pay-per-user billing system, a SaaS firm may recognize revenue upon registering a customer. Since SaaS software is ready-to-use, a customer may begin using an application as soon as they have been given access, and revenue is recognized at that point. When using the pay-as-you-go system, a CSP cannot post revenue at the time that a customer begins using the service. The reason being a customer has to reach an agreed amount of resource usage before they can be charged.

SaaS revenue recognition models are new and their utilization disrupted old revenue models posing many challenges to large, well-established packaged software firms. Although in 2013 most large firms, as demonstrated in the next chapter, have



restructured their business models to align their revenue models with SaaS, the transition continues to be painful. As Kaplan (2007, 48) recounts, before SaaS, software firms charged—on top of other charges—upfront, uninterrupted license fees and also fees for consulting to help customers adopt their product. Therefore, revenue realization was straightforward. With SaaS, such firms were forced to redesign their products, reshape their corporate cultures, and restructure their revenue recognition models, in order to remain competitive.

#### 4.3.2 PaaS vs. IaaS business models

PaaS and IaaS are both platform services in nature and the difference between their market targets is blurred. However, there are some distinct differences between the two. When it comes to application deployment PaaS offers a more comprehensive approach to the cost effective needs of Independent Software Vendors (hereinafter, ISV) by providing a software platform where ISVs can quickly deploy, develop, test and launch their product without owning and managing all the required resources. Services are delivered over the Web as development facilities, testing and release environments and tools for application lifecycle management. The provider lures customers with the promise of benefits in reduced costs, accelerated deployment and production, platform independent capabilities and well-established markets. The management of servers, networks, operating systems, and storage is the responsibility of the service provider. Even though, this helps developers to devote their time to developing applications, it gives them no control over the infrastructure their applications are deployed.

IaaS is a hardware platform. IaaS provides equipment for system operations such as virtual servers, load balancers, networking resources and data storage. Although the user does not manage the underlying infrastructure, they have more control as compared to PaaS. The client controls the operating system they use, space where their application is stored, as well as the application itself. Additionally, as stipulated in the Service Level Agreement (hereinafter SLA), the client has some level of control of networking components. Level of control and client responsibility are some of the main differences between PaaS and SaaS.

The main similarities in the two services are found in their pricing models, which is pay-as-you-go, and their delivery model, which is over the Web. The pricing models of both services make a perfect example of utility computing; because users are charged on a utility basis. With little variations, clients of both services are charged only for resources they use, billed monthly or yearly. In IaaS, a CSP calculates the chargeable amount, normally in cents, based on the amount of gigabytes of RAM used per hour. An IaaS cost formula typically looks as follows:  $\text{IaaS cost} = \text{compute hours} + \text{storage hours} + \text{software}$ . The PaaS cost formula is not as straightforward as its IaaS counterpart is and looks as follows:  $\text{PaaS cost} = \text{storage hours} * \text{number of API calls} * \text{price per API call} + \text{duration of queries}$ . The more the service is used the more gross revenue the CSP makes, making the elasticity of revenue from PaaS and IaaS positively related to resource usage.

Revenue is one of the most important measures of a company's health. Revenue realization is critical to the success of any business model. Yet, for CSPs, the concept of revenue realization remains a challenging accounting factor. It is not clear at what point in time revenue can be posted for services delivered over a long period. According to Sondhi and Taub (2009, 3.05), two concepts, earned and realized, should be clearly described before a company posts revenue. The concepts ensure that a company does not recognize revenue unless it has fulfilled its obligation stipulated in the contract of service and that it will actually receive the revenue in a form that is valuable to the company (Sondhi & Taub 2009, 3.06). The International Accounting Standards Board has some stringent guidelines that govern revenue recognition and other accounting standards that need to be followed to ensure correct practice. There is a need for further research to propose new revenue recognition models that are specifically targeted to the cloud service industry.

#### 4.4 Cloud and the gaming industry

For many game developers, technical skills are centered on creating content, not setting up the IT infrastructure necessary to deliver that content to end users. It has always been

an expensive affair for developers to get packaged games out on the market. A number of intermediate organizations are required between a developer and the shop where the game is to be sold. For a game to reach the consumer, a developer needs a marketing and distribution channel, game licensing agent, an internet service provider and then a shop for shelf space. The emergence of online and multi-player gaming brought a need for high performance gaming. Because developer companies did not have the required server capacity, players had to host their own games, something that brought its own set of challenges. To do away with all these shortcomings, developers turned to the cloud and Gaming as a Service (hereinafter GaaS) was the answer.

With cloud, developers are able to create cloud tailored games that run on dedicated servers and benefit from cloud's economies of scale. In the forefront of cloud gaming are Microsoft and Sony, two of the biggest players in the gaming industry. Microsoft has created Xbox Live, a gaming cloud for the Xbox One and Xbox 360 consoles located on the Azure Cloud. Sony collaborated with Gaikai, a cloud-based gaming service for PC and console. Xbox Live promises to solve many of the gaming industry's problems. There are many benefits of cloud gaming that may mean cost reductions and high quality user experience. The benefits of cost reduction and high user experience may be realized in the following ways:

- 1) No need to estimate how many servers a developer will need on launch day: when a developer wanted dedicated servers to run their games, they had to determine exactly how many servers they would need beforehand, and pay a premium to keep those servers running. With cloud, developers do not have to pay attention to IT; they just concentrate on content quality.
- 2) No need for ISPs: Developers have had to search for ISPs in all corners of the globe to host their games. With cloud, all games are hosted in data centers.
- 3) No server maintenance: Developers do not to maintain servers or copy new builds of their games to every server. All the work is done by the service provider.
- 4) New business model: When games are hosted in the cloud, the need for distributors, marketers, and licensing firms is limited, in some cases eliminated.

This creates a new business model with a new pricing model that is service oriented, creating a constant stream of income.

- 5) Positive user experience: The SmartMatch feature in Xbox Live offers smart matchmaking for players, which solves one of the major shortcomings of multiplayer gaming as far as user experience is concerned. Cloud gaming also has social networking features for easy sharing between players.

#### 4.5 Challenges of cloud: perfection or the next best alternative

Two of the biggest concerns that make consumers skeptical about cloud are privacy and security. It is unarguably true that the two concerns are real issues in the cloud. However, no matter how closely related these two issues are they are still different. The privacy issue stems from the worry of another party getting hold of private information, be it a cybercriminal or a service provider. The security issue involves safety. Security is broader than privacy and stretches out to physical safety. While privacy may be maintained by keeping data in-house, security can still be breached anywhere. Security of a home user or enterprise cannot compare to the security of clouds. Clouds have dedicated multilayered security systems that individuals do not have the capacity to operate, or cannot afford. Moreover, their physical infrastructure is guarded with top class security systems. Nonetheless, no system is infallible. No matter how secure a data center is, the staff making it secure can also be a vulnerability.

Regarding ecological concerns, in 2011, cloud energy consumption stood at roughly 1.5 % of the world consumption and 1.7% to 2.2 of that of the United States (Weinman 2012, 60). An average data center consumes as much energy as 25 000 households (Buyya, Beloglazov & Abawajy 2013, 2). It is a waste of resources for one establishment to use that much energy. However, a data center can support millions of thin clients, in turn reducing the number of thick clients in use. The reduction of thick clients in use is a potential way of reducing global energy consumption. The high virtualization in data centers allows a small number of buildings around the world to serve the whole world with one hosted application. This trend reduces the need for more factories to manufacture packages that need to be shipped around the world. The cloud

industry is committed to reducing greenhouse gas emissions. The industry has invested a substantial amount of money in energy efficiency technologies (Navigant Research 2013). The cloud industry Cloud will lead to a 38% reduction in global energy expenditures by data centers by the year 2020 (Navigant Research 2013).

In view of contracting, international law and service agreements concerns, contracts, and SLA in cloud are admittedly vague. Adherence to and consideration for international and domestic laws makes cloud contracts incoherent. It is challenging to trade generic Internet services across borders when national laws differ in every country. Nonetheless, contrary to packaged software firms, CSPs have data centers around the world and they are familiar with laws in every country they operate. For a cost sensitive company, it is cost effective to have IT resources in the cloud instead of purchasing them from a retailer. Therefore, clouds also save on travel expenditure.

There are also concerns regarding cloud interoperability, which is supposed to allow customers to migrate between providers. By law, every consumer has the right to choose a service provider. Critics suggest that CSPs trade on this right by offering proprietary software that lock in consumers. However, in competition between Microsoft and Apple operating systems, there were absolutely no compromises. Consumers were not given choices; they had to pick one or none. Cloud is the next best alternative and interoperability is part of cloud's fundamental composition. Other concerns are such as reliability and availability, cost of integrating cloud and complexity of cloud. This thesis maintains that these concerns can be overlooked if consumers regard cloud as the next best alternative instead of an infallible technology.

## 5 OPEN-SOURCE SOFTWARE IN CHANGING THE ECONOMICS OF CLOUD

This chapter presents the role of open-source software and its impact on cloud computing (hereinafter cloud). The first section presents the Openstack project, one of the most popular open-source Cloud Management Platforms (hereinafter CMP) in use today. The second section examines Red Hat's subscription model and its impact on the cloud market. The last section describes the freemium business model. The chapter examines how the promotion of cloud software released under various open-source licenses gives more benefits and choices to businesses and puts pressure on commercial software. Cloud software such as Openstack are at the forefront of this movement.

### 5.1 Role of Openstack in reshaping cloud

The success and influence of cloud is attributed partly to its promotion for open IT standards, global development communities, readily available free Application Programming Interfaces (hereinafter API) and the minimization of vendor lock-in (Red Hat 2013, 2). The Openstack project is a result of all these attributes. Openstack is an OSS project comprised of several software projects that form an IaaS software solution stack that enables organizations of any size and type to create and deploy infrastructure similar to that provided by public cloud service providers (hereinafter CSP) (Openstack 2013). Designed to run on commodity hardware, Openstack makes it possible for aspiring and established cloud providers to offer cloud services running on standard hardware. The project is an initiative by Rackspace Hosting, a cloud hosting firm and the United States' National Aeronautics and Space Agency (hereinafter NASA).

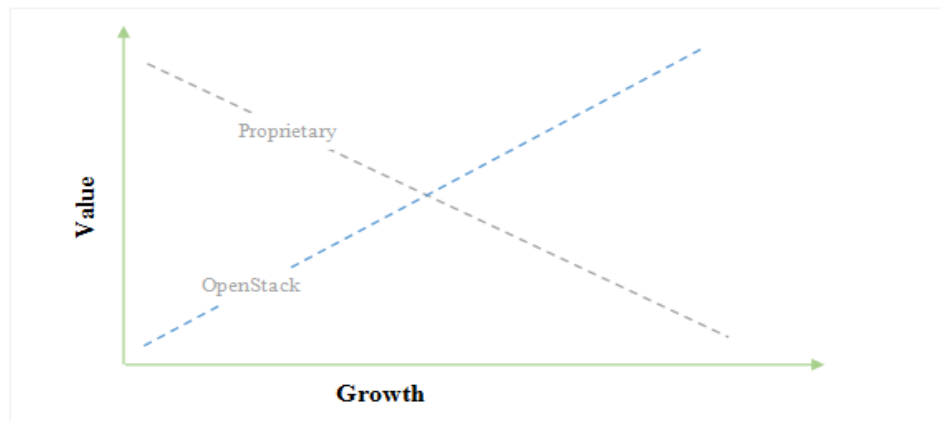
Openstack was first released in 2010 under the Apache License 2.0. It is now a large community supported by more than 9000 contributors and more than 200 companies including AT&T, Canonical, Red Hat, IBM, Cisco, Intel, Dell, Linux, SUSE Linux, and HP (Openstack 2013). Openstack has changed cloud in numerous ways, two notable ways are, minimal licensing fees and the possible elimination of vendor lock-in. Openstack as an operating system has capabilities such as computing, storage, and networking. Essentially Openstack offers the same capabilities as public clouds only free.

For an internal cloud or a business that offers cloud services, Openstack may be a viable cost saving choice over costly vendor locked-in commercial software such as VMWare's vCloud Director or a myriad of confusing Microsoft products. Commercial or proprietary software licenses are expensive; on top of that, the software comes with many hardware and software requirements that have licensing fees of their own. On the contrary, Openstack has affordable licenses and no hardware requirements whatsoever, and it even supports legacy systems and applications. The list of benefits continues as follows:

- 1) Customizability: an aspect of critical importance to enterprise IT besides licensing fees is the ability to customize orchestration to meet business needs. Open Source Software (hereinafter OSS) allows businesses to customize orchestration as needed. This feature is making an increasing number of enterprises choose OSS.
- 2) For many companies, cloud adoption is a forgone decision and implementation is well underway or on the soon to be implemented priority list (Williams 2012, x). Many organizations already have IT infrastructures. Cloud adoption is only a move to optimize their IT investment, improve existence services, or introduce new services. In such scenarios, paying for licensing fees for proprietary software is not an option. For such organizations, the choice is only between OSS i.e. Openstack and maintaining the status quo of their infrastructure.
- 3) Open-source encourages user-supplier collaboration: While commercial software comes pre-loaded with whatever the vendor deemed useful upon creation, Openstack allows IT suppliers to encourage well-informed users to participate in tailoring their software packages. Direct contact with users ensures that customers get value for their money and enables innovation.

The cost savings and number of choices that the Openstack operating system gives to users makes the choice between commercial software and OSS simple. On the other hand, derived value can only be compared to a certain extent. Due to differing company profiles, a task that one company considers costly may be an advantage to another. While OSS is free to use, setting it up requires more effort to design since installation

changes as often as it is released. Proprietary software on the other hand may have associated licensing costs; however, it has documentation that is more current and it is easier to install and get running. Moreover, a comparison of design, use cases, and features may prove that a decision between the two may not be predetermined. For a price-sensitive company, the shortcomings of OSS can be overlooked. For a price-insensitive company that lacks technical abilities, proprietary software may be an option. This value trade-off requires proper analysis before adoption is emphasized. Nevertheless, over time open-source appears to offer more value, as the figure below indicates. Figure 10 is the thesis writer's presentation of the value trade-off discussed above.



**Figure 10.** Long-term value: open-source vs. proprietary software

Figure 10 is a comparison of the long-term value of OSS and commercial software. The figure shows that commercial software offers more value in the initial stages. That is attributed to its ease of installation, better design, current documentation, premium support and more. However, as projects scale, licensing fees and premium payments become costly, diminishing value. Open-source communities do not put a lot of effort in designs and often offer console run software. Unfortunately, console scripting requires a lot of expertise and time. Furthermore, OSS documentation is often outdated due to the frequency of releases and lack of dedicated writers. Over time, as operations scale, Openstack offers more value because of its affordable or no associated licensing fees. OSS stands out to be a valuable replacement for commercial software.



## 5.2 Selling free software: Red Hat's model

The cloud industry has a host of uncommon business models, and Red Hat is proof of this statement. Red Hat is a US based multinational software company whose business is providing OSS products to enterprises. Using a community-powered approach, the company provides high-performing cloud virtualization, storage, computing, and middleware technologies. It also provides training, consulting, and support services. Red Hat is involved in buying proprietary software and releasing their source code under various open-source licenses. Red Hat's active contribution to OSS projects may be motivated by its exceptional subscription model.

Red Hat takes free software that it gets from its global array of community contributors across the globe and turns it into enterprise software that it sells together with source code. Its subscription model makes Red Hat's open-source business model distinguishable from the rest. Red Hat insists that they do not sell free software; instead, they sell the value of the subscription. This value comes largely through the Red Hat customer portal and the Global Support System (Red Hat, 2).

The Red Hat subscription is said to put control back in the hands of customers due to its contents. The subscription, which is billed annually includes, access to the product, meaning the binaries associated with the product as well as source code. Along with the binary, the subscription includes access to product revisions and upgrades. The subscription guarantees application certification, giving customers access to a certification ecosystem of a myriad of ISV applications and hardware platforms. Thus, it gives the ability to deploy a fully certified solution from hardware to applications. The subscription also includes access to the Red Hat network. The subscription includes the open-source assurance program, which is the legal open-source guarantee that Red Hat offers. Finally and most importantly, the subscription offers access to Red Hat's award winning unlimited technical support, customer portal, and knowledge base.

Selling subscription value is a unique business model to Red Hat and it makes selling free software possible. Proprietary software sells functionality. Contrary to that, there is

no selling functionality in free software because it is open-source. This is the reason why Red Hat focusses on a portfolio of sources of value, and customer support forms a huge chunk of this portfolio. Focusing on customer support allows collaboration, which in turn enables the company to include the human element in technology services. Consideration of the human element enables not only innovative software but allows users to take part in the development process. This subsequently influences user expectations, which is crucial in any industry. Ultimately, customers who feel cared for tend to be loyal. This loyalty shifts the odds towards OSS and chokes commercial software.

### 5.3 Understanding freemium business model

“Give your service away for free, possibly ad supported but maybe not, acquire a lot of customers very efficiently through word of mouth, referral networks, organic search marketing, etc., then offer premium priced value added services or an enhanced version of your service to your customer base” (Wilson 2006 as cited by Teece 2010, 178). This is the principle of the freemium business model. The term “freemium” is a combination of two important business words, “free”, and “premium”. In the cloud context, the freemium business model is a business model in which a software service is offered on a free-for-use basis, while it is supported through revenue from subsequent advertising and premium products.

There are two types of entities known to follow this business model: CSPs and Independent Software Vendors (hereinafter ISV). Common in SaaS, a CSP provides some features of its own software for free in order to charge a premium for extended features of that same software. In the same way, an ISV may directly offer some features of its software hosted by a CSP. The common scenario for a CSP is that it may offer an ISV’s free software and charge the ISV for the exposure. The ISV generates revenue from the premium sales and use it to support the free software. The CSP generates its revenue from advertising; hence, the notion of advertising-supported software and revenue.

This model may only be beneficial in Internet or cloud software business because it is designed to work best with services that target a large consumer segment. The model is mostly used in consumer, instead of business, software because consumer software has a near-zero marginal cost of delivering it to the client due to economies-of-scale. In addition, making revenue requires only a fraction of the number of consumers reached to respond to advertising (Katzen 2009, 259). Compared to the free sample product model, give away 1% of a product to sell the additional 99%, freemium is the total opposite whereby 99% is given away to sell the additional 1% (Anderson 2006 as cited by Katzen 2009, 259). This only works because of the huge number of consumers that cloud software can potentially reach.

The freemium model fits into the OSS and Clouconomics spectrum due its inherent use of cloud. The anticipation of selling to millions of consumers a service that has almost no production cost and a near-zero marginal cost of distribution fits freemium into the Cloud concept. Being able to make such a sell ensures high level of revenue that may be used to support more free services and innovation. It also works that if not even 1% of the target market responds to advertising, the provider does not make any significant financial losses.

The freemium business model is a crucial Internet business strategy that even the largest companies in the industry have recognized. To prove this, Microsoft's purchase of Skype is used as an example. Microsoft bought Skype for US\$8.5 billion in 2011 (Microsoft 2011). Skype had 663 million users in the year 2010 and made US\$860 million in revenue in that year, implying revenue per user of US\$1.30 (The Economist 2011). However, If only 10% of all users actually pay for the service then that revenue sum is substantial. Microsoft as an established service provider has a big chunk of the corporate market for IT who would be part of the paying user list.

## 6 CLOUD STRATEGY PROPOSITION FOR KTUAS

This chapter presents recommendations made for KTUAS to adopt cloud computing (hereinafter cloud) to reduce costs and enhance the quality of education, particularly in the Department of Information Processing (hereinafter Department). The chapter makes analysis of interviews conducted with some of the staff of KTUAS. Recommendations for teaching the concept of cloud in the classroom and the use of cloud technologies as tools for teaching and learning are made in this chapter. The first section discusses the significance of cloud in the education sector. The second section presents ways of integrating cloud into learning. Finally, the last chapter highlights possible challenges that may be encountered if these integration suggestions are considered.

### 6.1 Importance of cloud in education

The goal of every educational institution is to provide quality education and minimize costs. Quality education is adherence to quality assurance and cost reduction is efficiency and effectiveness. Quality assurance refers to regular, well-planned, and sustained consideration towards quality maintenance and status improvement (Vroeijenstijn 1995a as cited by Kis 2005, 3). In Finland, some universities of applied sciences (hereinafter UAS) were closed down and some merged to form new institutions. KTUAS is one of those that survived complete closure. Instead, the university was merged with the Rovaniemi UAS to form Lapland UAS. All these changes took place because the Finnish Government needed to cut costs. To avoid any future disruptions to the new institution, KTUAS needs to set objectives to reduce costs, be self-sufficient and most of all, produce high quality graduates. Cloud offers possibilities to achieve these objectives.

Members of staff interviewed were asked for views on the importance of cloud in future, in general and the education sector. Interviewees collectively agreed that cloud would be very important in future and that educational institutions cannot afford to ignore the concept of cloud. All interviewees understood that cloud is changing the IT

spectrum. Cloud's acceptance as the framework for providing IT services is inevitable. The economics concepts associated with cloud make it easy for organizations to make informed decisions regarding IT services. KTUAS has an opportunity to carefully consider these economic concepts and choose to keep with current evolving trends.

The Principal Lecturer in the Department believes that cloud is going to be very popular and education should recognize this trend and prepare to work with cloud applications. KTUAS should explore options that this technology offers. For a mature ICT establishment such as KTUAS's IT provider Lappia, the best option would be to turn the existing infrastructure into a cloud-oriented infrastructure and move some operations that are not mission-critical to a public cloud service provider. This is a case of a hybrid cloud deployment. Sensitive data would be kept internally on the private cloud and accessed from anywhere by authorized users. Data kept internally includes, bookkeeping, student records, examination papers, and all confidential information meant for internal use only. Operations and data meant for public use may be moved to the cloud. Due to government policies governing the storage and use of data, turning the current infrastructure into a private cloud would allow Lappia and KTUAS to have a full cloud system while maintaining data security.

The Lappia IT analyst interviewed recognized the economic benefits associated with cloud and he stressed that Lappia needed to consider cloud. However, he strongly objected to the adoption of mixed environments, in other words, hybrid clouds. He maintained that these environments double IT work and only half the benefits, citing the lack of IT staff. This is a valid argument from a technical point of view. However, it is more efficient to focus resources on missions critical to operations of the university i.e. data security, instead of allocating limited resources on tasks such as installing programming software on computers in different rooms. Qualified IT staff should not install software for students when there are other alternatives. Such staff should focus on developing systems that add value to the university and the surrounding community and ensure that the university is self-sufficient. This may help make the university relevant to government and the local community and ensure continued support. The IBM firm has the IBM Cloud Academy, an organization that helps educational institutions considering integrating cloud technologies into their infrastructure. This

would be a starting point for Lappia. Nonetheless, the analyst drew attention to the consideration of cloud services for Lappia's service desk software, which is approaching the end of its life cycle. His views are quoted below:

*“I personally believe that getting the service desk from cloud would be easier for us because we want our resources to focus on using the service desk; getting the tickets and using change management systems and problem management. We don't want to put our resources in installing and configuring SQL databases” –IT Analyst*

The interviewee's statement above is a clear example of the importance of cloud, especially for KTUAS with staff challenges. It is clear that organizations recognize the fact that the economic benefits of cloud outweigh technical challenges. KTUAS through Lappia should recognize this fact. Teaching tools from the cloud are economical. Graduates with knowledge of cloud in this technology age are more capable.

## 6.2 Integrating cloud into the classroom

After identifying the importance of the concepts of cloud in education, the next step for KTUAS is implementation. Four out of the five interviewees responded that the concepts of cloud should be integrated in existing course instead of being a dedicated course. One interviewee responded that the cloud should be both integrated and there should be a course dedicated to it. Therefore, the concepts of cloud should be carefully considered for integration into the curriculum. This does not mean a new course dedicated to cloud has to be introduced. However, cloud should not be ignored in the classroom. During interviews, the Head of Department stated that the new curriculum, adopted for the 2013/ 2014 academic year, is based on cloud, with a special focus on mobile and Web services. This curriculum naturally allows teaching cloud technologies and value.

One of the best suitable courses for cloud integration is Basic Computing Skills, in the study unit T402D12. This course teaches students how to use computers and manage files. KTUAS currently uses the Microsoft Office Suite 2010; however, it is inevitable

that when this software package expires, the university will move to Microsoft Office Suite 2013. This version of office, especially the enterprise version fit for universities is cloud-based in every way. Therefore, students should be taught how to use this software. The software is different from its 2010 version not only because it is hosted on the cloud, but because it includes numerous add-on applications necessary for efficient use of the software. This course would be best suited to prepare students to use cloud-based applications. Nonetheless, it is important to note that students cannot understand how they use software that is not saved on their machines, unless they know the basics of cloud.

Another best suitable course is Servers and Networks. This course teaches the basics of server installation and manipulation. Most companies today, big and small, use virtual servers. According to the Head of Department, one of the objectives of the new curriculum is to make graduates employable. For this objective to be achieved the graduates need to at least have the basic knowledge of how applications are deployed on the cloud and how servers and computing power is accessed. These graduates will either be deploying servers on the cloud or access them. This course could prepare these graduates how to perform these tasks.

The course best suitable for teaching a wide range of cloud technologies as well Cloudonomics is Service Oriented Architecture and Web Services. This course is directly related to cloud and there is no risk of diverting from the main lessons by including cloud in it. Service Oriented Architecture is an enabling technology that also exists in cloud. Therefore, creatively combining the two technologies allows teachers to include cloud services in their lessons whilst sticking to teaching service science. Numerous other courses would include certain cloud topics. It is only a matter of thorough examination.

During the interviews, lecturers voiced their grievances regarding access to teaching tools. Often lectures have their teaching tools installed on their office computers and they do not have ways to access them when needed in classrooms. Clearly having teaching resources hosted on the cloud can eliminate this problem. With cloud, all lecturers need is an Internet connection to have access to the tools they need. Lecturers

should only have to think about lessons plans, not application portability. Cloud-based Learning Management Systems (hereinafter LMS) and several other tools are good candidates to help our educators concentrate on knowledge sharing.

### 6.3 Challenges posed by recommendations

Chapter 4, section 4.5 of this thesis discusses challenges of cloud. Most of the issues identified in that chapter were raised by four of the interviewees. Therefore, for an effective cloud adoption more research would be necessary. It is important to note that the Ministry of Education in Finland has proposed the developed of a national cloud service. This prospect may possibly be the solution to challenges such as privacy, data security, and government laws.

Perhaps one of the most important challenges towards the university is the cloud subscription, particularly the pay per use subscription model. This is the model whereby consumers only pay for resources used. Hence, costs are incurred only when there is a user actually logged in to the service. However, in some cases when a logged in user leaves their workstation with a running session, costs continue to incur. This may be a very big problem when unwary students are provided such a service to use. Students often leave sessions running on computers. It may be that they suddenly need to rush to class, remember something urgent they had to do or mere carelessness especially with young students. To overcome this challenge, some providers offer configure systems to auto-terminate after a certain amount of time of idle state. Some providers simply leave it to the client to find ways to control this problem. These issues may be added to the list of factors to take note of when considering the above recommendation.

As additional information, attention is drawn to two matters that need to be reflected upon, the Microsoft DreamSpark account for students and KTUAS's Virtual Private Network (hereinafter VPN). At the time of writing this thesis, the DreamSpark account has 192 applications available for students to use. From experience and knowledge gathered through discussions with students, most students only use between three and five applications from that account during the three and half years they study at



KTUAS. The used applications are mostly operating systems and programming tools. Purchasing a license for 192 applications of which only five are actually used is not the most efficient way of using financial resources. If such accounts could be obtained from the cloud only the five applications would be paid for. Microsoft offers such applications through its cloud. Besides, not every student is aware that such an account exists. Most students in the BIT11 group only find out about the account at the end of the second year.

The VPN is another matter that needs to be resolved. The KTUAS VPN is inherently read-only. So are most VPN's of that sort. Unless KTUAS is not paying for this service's existence, it is strongly recommended to consider cloud. The current VPN does allow students to download documents saved on the university's network. However, as the Head of Department stated in the interviews, there are less and less contact hours and students work independently. There is certainly a need for a system that allows students to download and upload documents as required. Moreover, working from home means collaboration. Students working on group tasks have to communicate. Cloud offers solutions that do not only allow students to access files but also communicate and work on live documents in real time. There are numerous VPN and collaboration products available in the cloud that could ensure that the new trend of learning from home does not affect the quality of education. Solutions such as Google Apps for Education may be helpful in some of these instances.

## 7 CONCLUSIONS

Cloud computing is one of the several computing paradigms that assume to deliver computing as a service. Cloud computing (hereinafter cloud) has become universal and the decision by businesses to adopt cloud appears to be either made or being agreed upon but hampered by certain factors. Benefits of cloud adoption identified, among them, reduced costs of IT maintenance, ease of startup, and agility have made cloud an attractive alternative to conventional IT consumption. However, many businesses have already made long-term IT investment and the complexity of new technologies, particularly cloud may make them resistant to change. Therefore, the general aim of this research was to clearly examine the concept of cloud from a business perspective and subsequently determine what economic value cloud has for businesses. By exploring the concepts of cloud and Clouconomics, an argument for cloud adoption was made. The thesis presented and described the underlying technologies as well as the financial implications of cloud. Reference and examination of some successful cloud companies was made to solidify the argument. As practical output of these analyses, recommendations for cloud adoption by KTUAS were proposed.

The cloud technology is faced with numerous challenges stretching from hardware to contracts that permit consumers to use cloud services. Environmental protection organizations accuse cloud data centers of being harmful to the environment. Law and accounting societies are of the opinion that cloud does not conform to international standards. IT business analysts accuse cloud of being absurdly complex. The list of accusations goes on. However, when looking at the current IT trends with an academic understanding of the economics of cloud, these challenges are overshadowed by the gains of cloud use. Companies that choose not to move to the cloud now will eventually be forced to. As cloud matures, its pervasive nature will ensure that IT becomes a utility.

To summarize the findings of this work, cloud is a technology for enabling mass computing accessed through the Web with no geographical boundaries. Cloud is made up of three service models and four deployment models. Cloud is a new technology to a vast number of people. However, it is rapidly growing and maturing. Cloud can be

notably beneficial to any type of business establishment when adopted correctly. The new study of the economics of cloud is referred to as Clouconomics. A great number of people in the cloud business are not familiar with this study. However, as an increasing number of people begin to realize the power of service computing, the field will receive its due consideration. Clouconomics includes the study of how businesses can turn IT into a strategy and create new business models of exchanging software services for money and creatively capturing revenue. Cloud business models strategically place cloud service providers (hereinafter CSP) into positions where they can mass-produce and distribute services without exorbitant costs. In addition, these business models make IT affordable and computing more powerful than it has ever been. Open-source software plays a major role in changing cloud technologies and economics.

The study of IT as a strategic business maneuver is of significant importance to effective cloud strategies. Future research regarding IT as a business strategy may explore how CSPs have successfully adopted cloud as business strategy and how consumers can create strategies for business continuity based on cloud. Companies such as Amazon.com, Microsoft, and Google can be used to study how cloud can be strategic. There is ample academic research on these companies useful for further study. A study by Carr (2003) has some compelling arguments against IT as a strategy. These arguments could be used for an argumentative study.

Recommendations made in this thesis suggest that students from the Department of Information Processing could benefit substantially from the inclusion of cloud in courses. Moreover, the department administration could save costs by subscribing to cloud services and paying only for resources the department uses. For KTUAS to adopt cloud, the right infrastructure to improve the level of learning, reduce IT cost, and keep data locally managed is required. If a choice were to be made, a hybrid cloud would suit the needs of this university as hybrids leverage the flexibility of private clouds and the economics of scale of public clouds.

The Clouconomics discipline is becoming increasingly important. In future, more research will be conducted as an increasing number of organizations realize the importance of understanding the business value of cloud. Currently, mathematical

formulae are being increasingly used as metrics for numerical evaluations of this business value. The study of Cludonomics is not limited to the economic aspect of cloud. Instead, Cludonomics includes a systematic examination of the technical aspect of cloud. Combining the two aspects above creates a comprehensive understanding of the concept and business value of cloud. This is the strong point of Cludonomics; therefore, the reason why Cludonomics will significantly influence research in the field of cloud.

## REFERENCES

- Amazon Web Services 2013. What is Cloud Computing? Retrieved 23 September, 2013.  
<<http://aws.amazon.com/what-is-cloud-computing/>>
- Badger, Bohn & Chu, Hogan & Liu, Kaufmann & Mao, Messina & Mills, Sokol & Tong, Whiteside, Leaf 2011. Downloaded 16 October, 2013.  
<[http://www.nist.gov/itl/cloud/upload/SP\\_500\\_293\\_volumeII.pdf](http://www.nist.gov/itl/cloud/upload/SP_500_293_volumeII.pdf)>
- Buyya, Rajkumar & Beloglazov, Anton & Abawajy, Jemal 2013. Energy-Efficient Management of Data Center Resources for Cloud Computing: A Vision, Architectural Elements, and Open Challenges. Downloaded 27 October, 2013.  
< <http://arxiv.org/ftp/arxiv/papers/1006/1006.0308.pdf> >
- Harris, Derick 2013. AWS is the McDonald's of the cloud. Who's the Burger King? Retrieved 23 October, 2013.  
<[http://gigaom.com/2013/05/17/aws-is-the-mcdonalds-of-the-cloud-whos-the-burger-king/?goback=%2Enmp\\_\\*1\\_\\*1\\_\\*1\\_\\*1\\_\\*1\\_\\*1\\_\\*1\\_\\*1\\_\\*1\\_\\*1%2Eanb\\_1018287\\_\\*2\\_\\*1\\_\\*1\\_\\*1\\_\\*1\\_\\*1](http://gigaom.com/2013/05/17/aws-is-the-mcdonalds-of-the-cloud-whos-the-burger-king/?goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1_*1%2Eanb_1018287_*2_*1_*1_*1_*1_*1)>
- Hohtari, Sari 2013. Interview of Ms. Sari Hohtari, Head of Department: Information Processing, Kemi-Tornio University of Applied Sciences. Conducted 22 November, 2013.
- Hurwitz, Bloor & Kaufman, Halper 2012. Cloud Computing for Dummies. Indianapolis, Indiana: Wiley Publishers Inc.
- Kaplan, Jeffrey 2007. SaaS: Friend or Foe. Downloaded 3 October, 2013.  
<<http://www.webtutorials.net/main/resource/papers/BCR/paper125/06kaplan.pdf>>
- Katzan, H. & Downing, W. 2010. Software-As-A-Service Economics. Downloaded 27 October, 2013.  
<<http://www.journals.cluteonline.com/index.php/RBIS/article/view/500/487>>
- Kepes, Ben 2011. Cludonomics: The Economics of Cloud Computing. Downloaded 16 October, 2013.  
<[http://www.rackspace.com/knowledge\\_center/sites/default/files/whitepaper\\_pdf/Cludonomics-The\\_Economics\\_of\\_Cloud\\_Computing.pdf](http://www.rackspace.com/knowledge_center/sites/default/files/whitepaper_pdf/Cludonomics-The_Economics_of_Cloud_Computing.pdf)>
- Kepes, Ben 2011. Understanding the Cloud Computing Stack. Downloaded 2 October, 2013  
<[http://broadcast.rackspace.com/hosting\\_knowledge/whitepapers/Understanding-the-Cloud-Computing-Stack.pdf](http://broadcast.rackspace.com/hosting_knowledge/whitepapers/Understanding-the-Cloud-Computing-Stack.pdf) >
- Kis, Viktoria 2005. Quality Assurance in Tertiary Education: Current Practices in OECD Countries and a Literature Review on Potential Effects. Downloaded 26 November, 2013.  
<<http://www.oecd.org/education/skills-beyond-school/38006910.pdf>>
- Koskenniemi, Yrjo 2013. Interview of Mr. Yrjo Koskenniemi, Senior Lecturer of Kemi-Tornio University of Applied Sciences. Conducted 18 November, 2013.
- Kundra, Vivek 2011. Federal Cloud Computing Strategy. Downloaded 10 March, 2013.  
<<http://cdn3.ctovision.com/wp-content/uploads/2011/02/Federal-Cloud-Computing-Strategy1.pdf> >
- Lewis, Grace 2010. Basics about Cloud Computing. Downloaded 20 October, 2013.  
< [http://resources.sei.cmu.edu/asset\\_files/WhitePaper/2010\\_019\\_001\\_28877.pdf](http://resources.sei.cmu.edu/asset_files/WhitePaper/2010_019_001_28877.pdf) >

- Lindholm, Tuomo 2013. Interview of Mr. Tuomo Lindholm, IT Analyst of Kemi-Tornionlaakso Municipal Education and Training Consortium, Lappia. Conducted 22 November, 2013.
- Mankiw, Gregory 2008. Principles of Economics. Mason, Ohio: Cengage Learning.
- Mell, P. & Grance, T. 2011. The Definition of Cloud Computing. Downloaded 7 February, 2013.  
<<http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>>
- Microsoft 2010. The Economics of the Cloud. Downloaded 6 March, 2013.  
<<http://www.microsoft.com/en-us/news/presskits/cloud/docs/the-economics-of-the-cloud.pdf>>
- Microsoft 2011. Retrieved 6 November, 2013.  
<<http://www.microsoft.com/en-us/news/press/2011/may11/05-10corpnewspr.aspx>>
- Natis, Pezzini & Cantara, Skybakmoen & Thoo, Schulte & Feiman, Feinberg & Knipp, Murphy, J & Murphy, T, Malinverno, Duggan 2011. Platform as a Service: Definition, Taxonomy and Vendor Landscape. Downloaded 27 October, 2013.  
<<http://www.xray98.com/download.php?filename=Gartner%20Cloud%20Service%20Paper.pdf&postfilename=d9f2ddf94c4afb55.pdf>>
- Navigant Research 2013. Cloud Computing Energy Efficiency. Retrieved 30 November, 2013.  
<<http://www.navigantresearch.com/research/cloud-computing-energy-efficiency>>
- Navigant Research 2013. Cloud Computing to Reduce Data Center Energy Expenditures by 38% in 2020. Retrieved 30 November, 2013.  
<<http://www.navigantresearch.com/newsroom/cloud-computing-to-reduce-global-data-center-energy-expenditures-by-38-in-2020>>
- Ojala, A & Tyrväinen, P 2011. Developing cloud business models: A case study on cloud gaming. Downloaded 23 October, 2013.  
<<https://jyx.jyu.fi/dspace/bitstream/handle/123456789/36950/developing%20cloud%20business%20models%20a%20case%20study%20on%20cloud%20gaming.pdf?sequence=1>>
- Openstack 2013a. OpenStack: The Open Source Cloud Operating System. Retrieved 20 October, 2013.  
<<http://www.openstack.org/software/>>
- Openstack 2013b. The OpenStack Open Source Cloud Mission. Retrieved 20 October, 2013.  
<[https://wiki.openstack.org/wiki/Main\\_Page](https://wiki.openstack.org/wiki/Main_Page)>
- Openstack 2013c. Companies Supporting the OpenStack Foundation. Retrieved 20 October, 2013.  
<https://www.openstack.org/foundation/companies/>
- Pettey, Christy 2006. Gartner Says Eight of Ten Dollars Enterprises Spend on IT is "Dead Money". Retrieved 14 October, 2013.  
< <http://www.gartner.com/newsroom/id/497088>>
- Red Hat 2013. Doing Business with Red Hat. Retrieved 2 November, 2013  
< <http://www.redhat.com/overview/doing-business-with-red-hat/>>
- Ryabov, Vladimir 2013. Interview of Dr. Vladimir Ryabov, Principal Lecturer of Kemi-Tornio University of Applied Sciences. Conducted 22 November, 2013.
- Schubert, Lutz. The Future of Cloud Computing. Downloaded 21 August, 2013.  
< <http://cordis.europa.eu/fp7/ict/ssai/docs/cloud-report-final.pdf> >

- Sondhi, A & Taub, S 2009. Revenue Recognition Guide. CCH Inc: Chicago..
- Sosinsky, Barrie 2011. Cloud Computing Bible. Indianapolis, Indiana: Wiley Publishers Inc.
- Teece, David 2010. Business Models, Business Strategy and Innovation. Downloaded 2 November, 2013.  
< [http://www.econ.upf.edu/~lemenestrel/IMG/pdf/2\\_teece\\_on\\_bmi.pdf](http://www.econ.upf.edu/~lemenestrel/IMG/pdf/2_teece_on_bmi.pdf) >
- The Economist 2011. Why Buy Skype. Retrieved 6 November, 2013.  
<[http://www.economist.com/blogs/schumpeter/2011/05/microsoft\\_and\\_skype](http://www.economist.com/blogs/schumpeter/2011/05/microsoft_and_skype)>
- Vuokila, Johanna 2013. Interview of Mrs. Johanna Vuokila, Senior Lecturer of Kemi-Tornio University of Applied Sciences. Conducted 18 November, 2013.
- Weill, Malone & D'Urso, Herman & Woerner 2005. Do Some Business Models Perform Better than Others? A Study of the 1000 Largest US Firms. Downloaded 23 October, 2013.  
<<http://ccs.mit.edu/papers/pdf/wp226.pdf>>
- Weinman, Joe 2008. The 10 Laws of Cloudonomics. Retrieved 2 September, 2013  
<<http://gigaom.com/2008/09/07/the-10-laws-of-cloudonomics/>>
- Weinman, Joe 2012. Cloudonomics: The Economics of Cloud Computing. New Jersey: John Wiley and Sons Inc.
- Williams, Bill 2012. The Economics of Cloud Computing: An Overview for Decision Makers. Indianapolis: Cisco Press.

## APPENDIX 1

Appendix 1

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## Interviews transcripts

## Interview #1

Head of Department (Department of Information Processing)

**Q:** Are you familiar with the cloud computing concept?**A:** Yes I am. I do not know everything but I know the basic idea.**Q:** How important do you think cloud computing will be in future in general and education?**A:** In general, I think there will be an increased use of cloud computing in the whole area of ICT and in many other fields too. It is a question of software and different kinds of services. I think in the future, software will be more and more cloud based.**Q:** Does our university have any plans towards the use of cloud computing?**A:** In our department yes, I do not know if you are familiar with our new curriculum. However, it is mostly based on cloud computing, especially Web and mobile services. Therefore, I think it is the key issue within our degree program. However, if I think about other degree programs, I do not know what services and tools they will be using in future. I think that they will apply more and more different kinds of tools and services that are based on cloud computing. If you are asking about the organization itself, I do not have any idea. You should discuss it with someone working in the ICT department.**Q:** Are there any advantages that you can point out in the use of cloud services, especially in education?**A:** When we were developing this new curriculum, we were thinking of students' possibilities to get jobs in future. Based on that, we decided to focus more on cloud computing and mobile services. If you think about Finland and especially this Northern part, there is a lot of space and less people. So in the future, almost all the services would have to be available 24/7 and online. That requires knowledge of cloud computing and mobile and Web services from our students, because I think



most of them will get jobs based on these three main topics. That is why we decided that cloud computing and Web and mobile services would be the main topics in our curriculum. However, soon after we made this decision we were reminded that, as an example, in Africa, in many countries they are creating mobile applications because it seems to be the most reasonable way to offer services to a large number of people in different locations. This seems happening worldwide nowadays. I do not know if you are familiar with what the European Union has been discussing lately concerning cloud computing and different kinds of mobile and Web services. I was surprised because living in Finland; it is not that easy to see that things are not the same even inside Europe. It was approximately 3 weeks ago that the European Union had a special conference for Web services. In that conference, they talked about different kinds of online services that should be available to everyone living in the European Union. They knew that situations in different countries are not the same. Some countries have more services available and in some not. Now they are trying to make a decision on what kind of Web services should be available for all people living in the European Union area. It seems that there is a huge amount of work should to be done to create these services for the people. In that discussion they mentioned that there are more than 30 000 jobs available now for this kind of development. In addition, in the future there will be even more. So imagine worldwide, Africa, North America, South America, and Asia. Therefore, I think that there will be many job opportunities for our students especially if they study in this area. An I think that in the future it will be more and more cloud based because not all companies and organizations are willing to buy their own equipment. If you think of providing these kinds of services, it means that you should have different kinds of servers, and hardware systems and networks systems. Therefore, I think that it is easier to buy these services from someone and then establish everything based on cloud services. That is my opinion now. I have noticed because we have our own servers and you should be able to invest money to all these equipment at least every 3 or 4 years. It is quite expensive to keep all these hardware and servers running. Investments are too big to be honest. If you think about ICT, you need to have good equipment, good tools, and connections. Without those, you cannot manage in the future. It means that you have to buy this equipment all the time to be in the top all the time. Therefore, it requires a lot of

money if you are doing it yourself. However, if you can buy the service from someone who is maintaining all these hardware and everything then it is not that expensive. That is what I think now. You do not know what is going to happen but it seems that is the situation now.

**Q:** What challenges do you think cloud computing poses to our university?

**A:** From our program point of view, I think the hardest thing is that we should have good students who can really learn in the ICT field. Not just the basic things but even deeper level. I mean programming for example is quite difficult for some students to understand and it has always been like that and I do not think it will change. However, the key issue for our department is how to find those students who are capable and interested to study in our program and who will graduate. Nevertheless, from the technical point of view, I do not think we have that many difficulties and our teachers they are more or less familiar with this concept because some sort of cloud was already there back in the 80s or the beginning of 90s. However, not at this level and it was not a similar system but still the idea was the same. Therefore, I think that for our teachers, it is not a big issue. Find the students who are able to study in this program and who will graduate is the problem. Because if we find good students who have all the skills and possibilities and they will definitely graduate and I am sure that they will get jobs in future. I do not see how they would have difficulties in find jobs. However, if you think about the whole faculty, when we discuss business and the culture, I think that in their situation they can use different kinds of solutions that are based on cloud computing. However, I think most students and teachers are not familiar with what cloud computing means nor are they familiar with the kinds of services provided. I think for them, I do not know they need to have some sort of education and there should be a change in their curriculum. Teachers should have some sort of training to catch up what are the latest possibilities for them, from their point of view. Especially when they are using different kinds of tools, for example accounting or software which are used in business, those can be also provided based on cloud computing. The main issue is, are they familiar with that kind the services? We should check first what services are available and what are useful to our students' point of view. In addition, of course teachers need some knowledge about those services. Therefore, I think that the teachers need training to be able to use these

kinds of services in the future. That is only my opinion. If you think about organizations point of view, it think that it is the same situation also concerning the whole organization. However, I think we have a different situation in our department. We have a different opinion and we are familiar with technology. The others need information and they need to find out what possibilities they have. If it is possible for them to use those new services and so on. Even though I think that, many students as well as faculty members do not understand that they are using services but they do not understand that those are cloud-based services. They do not know how those services are actually provided and created.

**Q:** Do you think cloud computing should be taught as a course in our school? If so, should it be a dedicated course or integrated into another course?

**A:** Both, because I think, first students have to know what cloud computing is and then everything can be integrated. However, in the beginning they should know what cloud is computing because I think students are not familiar with this concept. Therefore, I think that we have to introduce it to students before we start teaching. Otherwise, they will be confused, asking, what is cloud computing? Am I involved with it somehow? It is the same thing when I talk to the new students and I tell them what we do here at school. Most students, mostly young people, do not know what it is we are doing here. If you tell them that we are teaching programming, designing, and databases, they do not understand what that means. However, if I ask them, do you use Facebook? Alternatively, do you use online bank systems? We are the ones who make the software for those services. Then they look at me like, oh really. We do not only use we create. Then they say, ok now I understand what you are doing. I think in the same way, we have to introduce cloud computing to our students. Other faculty members who are not in our department, have the same situation, and someone should introduce this concept to them. Especially how they can use it in their own tasks and own work when it is about teaching.

**Q:** How do you feel about having teaching tools or software sourced directly from the cloud, instead of having them installed on our computers?

**A:** I think that we should use more and more tools that are based on cloud. Then for students, those tools are available online 24/7. Otherwise, if the software we use is installed locally or just on our network it means that students can only access those services when they are at school. That is not good from the students' point of view.

To be honest the amount of contact hours is so low. Because the students are not here the whole day and the amount of hour is so low, it means that students are working independently quite a lot. In addition, if they are not here, then it means that they cannot use those services, which are provided locally. Therefore, it is not a good situation. Instead of these local services, we should offer something, which is available for the students anytime, no matter where they are. That is my opinion.

## Interview #2

**Vladimir Ryabov**, Principal Lecturer (Department of Information Processing)

**Q:** Are you familiar with cloud computing?

**A:** Yes, I am familiar with the concepts of cloud computing and I have subject knowledge in this field. I think cloud computing is very important in the future and it is already now. I strongly advocate the use and application of cloud computing concepts in education because I think it is very relevant.

**Q:** How important do you think cloud computing is going to be in future in general and education?

**A:** I think cloud computing is going to be very important in the future because it's changing the concepts of using IT in many businesses, especially in small and medium size enterprises. Cloud computing has a totally different economic concept behind it, which makes it more easy for many companies to use IT applications. It does not require any special knowledge for them and it reduces the costs of the use of IT services in businesses. Therefore, it is definitely going to be very popular and education should see this trend and should prepare people to work with cloud applications and to design services.

**Q:** Are there any disadvantages that you can point out in the use of cloud services, especially in education?

**A:** Well, I would not say they are not disadvantages, but challenges. Definitely, the concept has challenges. One of the challenges from the business point of view is that you give up all the data maintenance and management to a service provider, which might be tricky from a security and privacy points of view. In addition, let us say that not all business applications are able to do that. There are many sensitive businesses, like medical applications. They simply cannot afford to give their data to a third party. Or police, for instance. So, information security and privacy is one of the issues of course.

Another challenge might be that cloud providers promise you that it is going to work. That it is going to be stable, it is going to be accessible all the time. We know

that in some cases it still might be a problem. For instance, SAP is using Amazon Cloud Services to offer access to their latest software HANA, a database management system. It is software for business analytics. I have been participating in HANA training in September in Munich, organized by SAP. And we had to use this software, which was physically located on Amazon Cloud servers. It was tricky, because it was not accessible all the time. This is only one example of when the concept should work well but since you cannot control the implementation of these services, you should rely on the service provider. Even Amazon is a reliable provider...then there might be some challenges, which are not in your hands. You can imagine that for some business applications, if you cannot access the application and it is not in your hands...it does not look very promising.

**Q:** Do you personally believe that policies governing the use of information could hamper the adoption of cloud computing by our school, especially if a provider would be an international company?

**A:** Well, I think that cloud services should be adopted by the school, and we have to include them into the education process. So far, I think internal IT infrastructure of the school should be based on the concept of services, and providing services to different parts of the organization. By that way, we are not saying that we have to utilize services of an external provider, it might be services provided inside the school by the IT department. I think this is a concept that is much better than what we have right now.

**Q:** Do you know of any plans that our school might have regarding cloud computing?

**A:** The BIT degree program's new curriculum, which is implemented already from this year. We start a new group according to that curriculum. The main topic in that curriculum is cloud computing and Web services. That is the focus of this new curriculum. I think this is a very big move forward because now we would like to incorporate cloud computing in almost every course we are teaching. Cloud computing and designing Web services, which I believe is the future of IT.

**Q:** Do you think cloud computing should be taught as a course? If so, should it be a dedicated course or integrated into another course?

**A:** I believe that cloud computing and technologies of cloud computing should be studied in many courses. It should not be a subject for one course, it should be a background for most of courses, also programming for instance. Because it is not

something you study in one course, that is more or less a philosophy. You are designing software to be used on the Internet, offered through the concept of cloud computing or Web service. It should be integrated in many courses and I would like to believe that it is integrated in the new curriculum.

**Q:** As a lecturer yourself, how do you feel about having some of your teaching tools come from the cloud?

**A:** I do not mind that, and I think it provides also some flexibility for us because we don't need to buy licenses. We can only pay per use for some services, making education more flexible because we can easily change the service provider, which is also one of the advantages for businesses who use cloud services. They can easily change service providers if they are not happy about something. Previously we had to buy licenses for some software, and of course if you pay a lot you have to stick to that. If you change, you give up a lot of money. Also in business if you pay per use, then you can change the provider if you are not happy with something. I think this is a very good thing.

**Q:** The Ministry of Education is planning to build a national cloud service for education. Do you think such a service would eliminate the issue of privacy?

**A:** It is quite popular in different business applications to build so-called private clouds for certain organizations and enterprises. In that point of view, it might be a good idea to build a separate cloud for Finnish education institutions, because definitely this will help to control private data, which are obtained. So I think that is a good idea and it has some potential.

**Q:** Do you have anything else you would like to add? General comments or cloud specific?

**A:** Not at the moment.

## Interview #3

**Tuomo Lindholm**, IT Analyst (Kemi-Tornionlaakso Municipal Education and Training Consortium, Lappia)

**Q:** Are you familiar with the cloud computing concept?

**A:** somewhat, I understand the basic concept and I know that there are different kinds of services and possibilities.

**Q:** What plans does Lapland University of Applied Sciences have regarding integrating the two universities that are coming together in terms of IT?

**A:** Well, now there are no final agreements. Cooperation is still in development mode. Now it is agreed that there is one service area, which is called LUC Service Area. It includes Lapland University, Lapland University of Applied Sciences, and the municipal federation of Rovaniemi education. I do not remember how it is exactly said. Lappia is cooperating in this area but does not take part in development activities. All cooperation between these four schools is arranged with separate contracts with Lappia. Therefore, this is a bit of a difficult situation now but it is developing. I say “we”, as in Lappia, we are taking part in cooperation in development activities, we can work on those but we are not taking leading positions. So we do not ignite any development processes. However, if there is one we may go along.

**Q:** How do you feel about sourcing teaching tools i.e. software from a cloud provider instead of the university buying licenses?

**A:** That is a difficult question because every software should be treated differently to understand how the license costs form. If it is cheaper to buy a cloud service for example licensing it with licenses of same time use or reserved licenses for some named persons. What I mean, there are so many licensing models that the economic information must be product specific. However, my personal opinion is, of course we should use cloud computing whenever it is the most suitable solution for education’s needs. Because I do not think the core business of our educational institutions is to own licenses. What we do is we teach how to code and others, we



are not in the licensing business, we are in teaching business. So it is easier to have cloud computing access for different tools because when a method of teaching or maybe there will be a new programming language which requires new tools. The tools are quite expensive. Therefore, purchasing of those tools and then installing them may take from 3 months to 6 months. If we were able to get them fast from cloud services then of course we should use cloud because it leaves out the installation procedures and buying licenses. So there must be ongoing evaluation of the tools and costs compared to the education point of view.

**Q:** When a teacher needs certain software for teaching they have to go to the designated class to check that the software they need is installed on computers in that class and if it is compatible with students' different operating systems? How do you feel about that?

**A:** There is a huge communication gap between IT and education. Actually, that is what my own thesis is trying to fill. However, the point is that, I do not know if teachers know that in our intra services we have updated information about what is installed and where. We have a map for every classroom. So if teachers want to know what is installed and where, the information is available.

**Q:** Did you make it known to teachers that there a place where they can this sort of information?

**A:** I do not know. We have, I would say customer managers who talk with education. However, we have published that information to all heads of department. We always ask; do you still need this? This costs amount X, how much do you need this, and stuff like that. So we use our client management systems to collect inventory data and compare or categorize it according to classrooms. There is also the problem that whenever there is new software, we usually do not get information until the course has started.

**Q:** Do you think cloud computing should be taught as a course? If so, should it be a dedicated course or integrated into another course?

**A:** Yes, of course, you have to have general knowledge and understanding of what can and should be done in cloud computing for students. I do not know how it could be educated because making the decision to get something from the cloud, be it infrastructure, services needs research. It is always based on the company strategy. In addition, mixed environments from my point of view are the worst, because then you have double the work and half the benefits. So students should be

taught the different options of cloud computing and the value that it could provide. Some companies live from having their own servers. Some have information that they cannot put on the cloud. Some companies do not need anything more than Google Apps. Therefore, you cannot have a course that would consider all these options. You get it through experience. Of course, the understanding of the main business, which IT always supports.

**Q:** Besides the program we talked about earlier, are there any other plans that may mean IT services for the integrated universities would be sourced from the cloud?

**A:** There are not actual development projects and of course, we are always following the trends and analyzing the situation. Two days ago, we were in a meeting in which we discussed our current service desk software. It is at the end of its life cycle and we are not going to upgrade it. So now, we have the option to get it from the cloud and we have the option to install it locally. Therefore, we are really trying to decide what would be suitable for us. I personally believe that getting the service desk from the cloud would be easier for us because we want our resources to focus on using the service desk; getting the tickets and using change management systems and problem management. We do not want to put our resources in installing and configuring SQL databases. It is easier to buy those services. We do not have extra resources anymore that we are diving Lappia and Kemi-Tornio University of Applied Sciences to Lappia and Lapland University of Applied Sciences. In my personal opinion, one of the difficult situations is that we do not have a person who is capable of being a database admin, whose duties would be mainly aligned with fine-tuning our SQL databases. And, we have a lot of databases. We have Microsoft, Oracle, MySQL and more. Nevertheless, there should be someone to work on these databases because, for example, our service desk has so many transactions all the time. It should be connected with the configuration management database and other databases that have inventory data and configuration items. Those kinds of databases require optimization and it is a difficult job. Well we have general knowledge of how to operate databases but specialists. However, of course I am not sure we have enough databases that we should have our own specialist. So why would we not buy the service from a cloud provider. It is not always useful to own the service; you only need to have access to it.

**Q:** Do you have any comments that you would like to add to this conversation?

**A:** At the moment, Microsoft is pushing hard for its cloud services for email and well, almost everything. It is a tricky situation because many of the schools think that they can get student emails from the cloud because they get more disk space and it is integrated to Lync. However, they still would have the same server systems for staff emails. In addition, for all student emails to be in the cloud, you have to build a system that would connect the cloud system and your own directory service. Which requires, I think, a minimum of four servers. Therefore, what you get in the end is more disk space for students and a Lync connection that I do not think works now. Then you still have to do everything you did before and maintain four extra servers. I really do not know what the point in that is.

Another case is that software providers like Microsoft and others have noticed that selling licenses will only get you a bit of money. However, if you sell the same service from cloud you get money from server maintenance, backup support activities. Maybe that is the reason that they are offering services. They are not on welfare they are business. It could be that in the near future, some of those products currently sold to companies would no longer sold. Instead, they would be offered. This is not only about Microsoft we can see it from, Adobe Creative Suit. Adobe is now pushing hard from the cloud. I assume 3D studio they are coming there, because it is better business. However, what is the use from the view of education, I do not know, but it is always a case specific questions.

The trend is that education requires more and more systems because the world evolves. However, we are not able to shutdown anything. Therefore, there are now two times more systems than we had, two years or five years ago. We do not have any more workers. We have to find ways to get resources. Automated systems would help but automation requires efficient communication. If you do not have input from somewhere you do not have a process so you cannot automate. Even most up to date cannot fix faults in the organization. The organization must learn and build the IT process and then choose the proper technology. That is my ideology. First, we get things working, for example on paper. We draw how things should be and then we choose technology. After the

technology has been chosen, we can then select if it is easier to have it from the cloud or have our own. Therefore, it must always go top down. If IT takes charge here, of course IT tries to develop things that will make their work easier. However, is it always better for education? That is a big question because IT would say, oh, we can have all those from cloud then we do not have to the maintenance work and we could focus on something else. However, it could be that it is not easy to use them during education. In addition, if you have let us say, 15 contact hours divided into 3 sessions it may be that 1 of the sessions, this cloud is not available. So what do you do then? Those things should be considered. And of course, there is private cloud, which is expensive, but for educational organizations, it is affordable if two share one cloud. There are so many options that you just have to focus somewhere and follow your company strategy. You can quite cheap server space for example, for your own Web server from the cloud but if you build on top of it, you have to pay. You have to decide what is the size of your business and if it useful. What are important things, for example, the disk space for email, is it important? Could there be some other way to store the data. Why would teachers or students require 7 gigabytes of email? I do not understand because you do not have to transfer all your music videos. You can make PowerPoint of less than 15 megabytes.

## Interview #4

**Johanna Vuokila**, Senior Lecturer (Department of Information Processing)

**Q:** Are you familiar with the cloud computing concept?

**A:** Yes

**Q:** How important do you think cloud computing is going to be in future, in general and education?

**A:** I think we are moving towards the direction of cloud strongly. However, of course it will take time to move everything to the cloud, so that everything is located there. Using common sense, you can see that cloud is practical, in the sense that all people need is a client to be able to use computing resources. For personal use, you do not need to know how to install or configure software; therefore, it makes life easier. For organizational use, cloud makes using new software solutions easy.

**Q:** Does our school have a cloud strategy?

**A:** I do not know about the school's IT strategy. What I do know is that, with the merger and formation of a new university, there is an IT strategy, I am just unfamiliar with the details.

**Q:** Do you personally think that cloud computing has benefits to the school?

**A:** Yes I do. Software used by staff could be sourced from the cloud. Tools used for teaching could also be cloud based. However, as we the business and technology department, BIT have to understand how these services work. Cloud should be familiar to us, we have to understand its structure, how it is created, and how users connect. Therefore, there are two aspects, we could use cloud software in teaching and administration, and we the BIT department need to understand the technical part of cloud. Understanding is not a problem because clouds have always been there; it is just a new name for an old concept.

**Q:** Are there any disadvantages that you can point out in the use of cloud services, especially in education?

**A: 1)** Cost is a big concern: Expenses are paid monthly or yearly but it is hard to calculate them. Extensive research is required to determine what kind of software can be sourced from the cloud, who is offering it and how much it cost compared to our IT status quo.

**2)** Security and privacy: organizations such as the police, hospitals, banks, and schools have sensitive data that many times may not be moved out of premises without breaking the law. However, if you are using some photo editing software for general work then those concerns do not exist.

**Q:** How do you feel about teaching cloud in the classroom as a dedicated course or integrated into an existing related course?

**A:** I do not have a problem with that. We do have to keep up with technological developments.

**Q:** Would lectures such as yourself require any kind of training to be able to teach cloud?

**A:** Speaking for myself: No, I would not need any training on the concept of cloud. It is an old concept with a new name. However, I am not familiar with servers and networks. Therefore, if I had to teach something technical I would need training.

**Q:** Cloud is said to reduce costs in terms of licenses and improve productivity in the IT department. Do you agree with this claim?

**A:** I do not agree nor disagree. I think that one needs to calculate costs of cloud and compare that to how much it costs to have staff in the IT department. Again, as I said in the beginning, there is a need for research.

**Q:** Do you have any comments that you would like to add to this conversation?

**A: 1)** From a teacher's point of view, disregarding administration, IT department and other staff. When a course requires a certain piece of software, I have to go to the classroom where lessons will be held to see if the required software is installed on desktops in that classroom. If the software is not installed or it just does not work properly, I have to call IT support. If students will be using their laptops, the teacher has to provide a download link to the software and wait until everyone has downloaded and installed it before the lesson can commence. Furthermore, during re-examinations conductors have to ask the responsible teacher whether students need a certain software for the examination. Afterward, they have to check that the software is installed on machines in the examination room. The teacher believes

that in this regard, cloud would be notably beneficial. Software would be available online in any classroom on any computer. This would save time and effort, and allow teachers to rather concentrate on preparing quality lessons.

2) I am skeptical about overall promises of cloud computing. Again, I remind about the silver bullet syndrome. I think, cloud computing might be taken as the solution to all IT problems ever faced. However, there is no solution able to solve all IT problems.

## Interview #5

**Yrjö Koskeniemi**, Senior Lecturer (Department of Information Processing)

**Q:** Are you familiar with the cloud computing concept?

**A:** Yes, I am familiar with cloud computing

**Q:** How important do you think cloud computing is going to be in future, in general and education?

**A:** Generally, I think it is going to be useful and very important because all the data will move to the cloud somehow in the future. We will not see it happen but one day all data will be located somewhere in the cloud. We do not really know where the cloud is but we can use it even in education. You will save your data on your home computer but you will have a backup somewhere in the cloud.

**Q:** Are there any specific advantages that you can think of, which cloud computing offers to an establishment like ours?

**A:** Thinking about the school for example, cloud means that users can have their own clouds or if the school can offer space for students, they can access data whenever and wherever they want to. We do not need many servers here in the school. It helps people do real work else instead of updating servers. Even though, something has to be done for the clouds as well but there are companies who do this.

**Q:** Besides concerns of privacy and security, what obstacles do you think cloud computing poses for our university?

**A:** I do not know if I think about the school, like myself, the only time I need privacy is when I use my private email and when I grade students. Information about grades and student records must be kept private. For example, the teaching material, and all other material, it is not an issue of security because it can be available to anyone who wants to learn something. My material are always public, I do not have any secret material in my lessons. Anyone who needs them can use them.



**Q:** Does our school have a strategy for adopting cloud computing in future?

**A:** I do not think we have such kind of strategy. However, we have IT services and Lapland University of Applied Sciences has a strategy. They are talking about clouds but not in the meantime. Now they are concentrating on how to integrate existing systems together. I think they have a lot to do because student records and staff records must be integrated. However, we already have a cloud system, Moodle for example. It is on our servers but you can access it from anywhere. What I have learnt is that we do not really have a strategy that we are moving to clouds, in the students drive space for example.

**Q:** How do you feel about teaching cloud computing in the classroom as a dedicated course or integrated into an existing related course?

**A:** I would integrate it into existing courses because even though we talk much about clouds I do not see it as a very special thing. During the times when I have been working in IT, many technologies have come and gone. However, they do not really change it is just a new way to save the information. When we are working with programming, we have to know how to connect to the cloud. It is part of the programming course that we have a cloud or an SQL server somewhere in the cloud. Alternatively, we have a Web server that has located somewhere we do not know but we just have space there. I think it is part of our courses, we have to consider it, and we have to know it. I do not think that we should have a special course for cloud computing because it will be visible everywhere. Of course, we can talk about it but we do not need a specific course. Just integrate it every needed. It can be a part of basic computing skills. If you are saving an Excel sheet, are you saving it in your local drive somewhere like Google Docs.

**Q:** How do you feel about sourcing teaching tools from the cloud?

**A:** It would be helpful of course. For example when I think about my work, most of the tools are free tools but I have to install them on my computer. It would be easier if they were available everywhere I teach. It would be easier if the common tools we use would be available that I could just login somewhere and access them anywhere. That way I would not have to install anything on the computer. Some of my applications are now on my office computer and I cannot access them anywhere else. Because some of the applications they need to be installed on the computer. For example when I am teaching programming for applications, for example mobile

applications, all the tools I can get them freely but the tools need to be installed in your computer. Ok programming is something that you have to do in your computer but there are some tools available elsewhere. For example when we use PhoneGap there is a cloud service that you can have access to. When I'm creating an Android version I can compile it to iPhone and Windows Phone versions in the cloud.

**Q:** Do the free tools that you use give you any compatibility issues?

**A:** No. Not in the case Web applications, PHP and MySQL that you can use in Linux, Windows and Mac. However, for the mobile applications of course, then it is different. You have to have Android tools to create Android applications. For Windows you have to have certain tools and for iPhone, you have to have the Xcode. Sometimes the issue the operating system or the platform you are using.

**Q:** Do you have any comments that you would like to add to this conversation?

**A:** I think I would say that somehow we will have clouds available anywhere. For example, they will be in our homes and our cars. You will have access to your information in your car, when you go home or to the office, you can access the same information. That is why we need clouds. There are many different applications available in the cloud of course. But for education for example when you think about laws in Finland, when you save student records you have to keep them here. Even for companies, when you think about taxation laws and auditing laws in Finland, it says that you have to keep your bookkeeping information in Finland, according to Finnish law. In that case, if you try to use cloud services for bookkeeping can you be sure that the information is located here in Finland. There are some laws that we have to think about. The more we use cloud services, there will be issues that have to be taken care of. For example, bookkeeping in the cloud might be good if you think of small enterprise who only want access to that application. But if the bookkeeping service is located outside Finland then it's against the law. I think Finland tries to make those companies have their services in Finland. Even we have quite balanced nature. Ok we have a long hard winter but we do not have hurricanes and storms.